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OF THE

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OF

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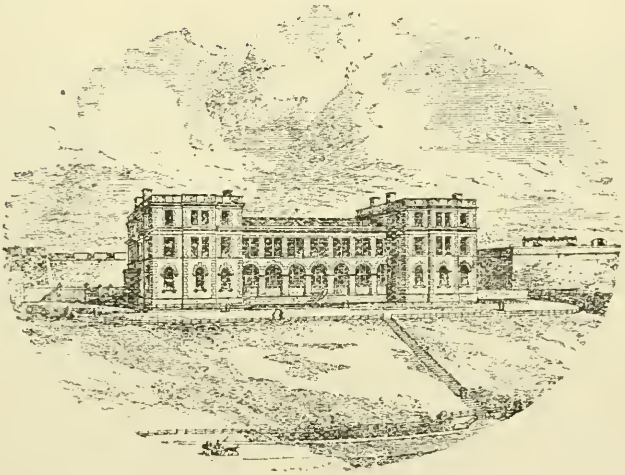

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The Impoverishment of the Sea.

A Critical Summary of the Experimental and Statistical Evidence bearing upon the Alleged Depletion of the Trawling Grounds.

By

Walter Garstang, M.A., F.Z.S.,

Naturalist in charge of Fishery Investigations under the Marine Biological Association;
late Fellow of Lincoln College, Oxford.

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INTRODUCTION.

IN the present essay I have endeavoured to bring together the most precise and reliable evidences available as to the recent and present condition of the great trawl and line fisheries of England and Wales. Both these fisheries depend for their success upon the same fundamental conditions, viz. the abundance of fish upon the bed of the sea. They may rightly, therefore, be grouped together under the single head of "bottom fisheries," in contrast to the fisheries for herrings, mackerel, and pilchards, which are "surface fisheries." From the nature of the case, even great fluctuations in the annual produce of the latter fisheries scarcely excite surprise, but a fairly constant yield is tacitly expected of the bottom fisheries, when the same apparatus is employed, owing to the greater uniformity in the conditions of life on the sea-floor.

It is probable, however, that the extent to which the stock of fish on the sea-bottom depends upon variable elements, largely influenced by the weather, is not fully appreciated even by the experienced fisherman. The reproduction even of bottom fishes is profoundly affected by the conditions of temperature, wind, and salinity prevailing at the surface and inshore during the breeding season,* since the majority of sea-fishes produce pelagic eggs, and many of them pass their early youth inshore. Temperature affects both the duration of the period of incubation and the rate of growth, directly by its action upon the metabolism of the fish, and indirectly by its influence on the growth and multiplication of lower organisms available as food. Changes in salinity may kill the larvæ, stunt their growth, or create an impassable barrier to fishes on migration. Unfavourable winds during the spawning seasons may drive millions of eggs and larvæ to a premature death. Even if the local weather, during any given term of years, be admitted to have shown no marked abnormality, it is always possible that weather changes of great magnitude beyond the region of the fishing grounds may so divert the great ocean drifts from their usual courses as to modify appreciably the normal distribution of temperature and other factors within the region. The recent hydrographic researches of Dickson, Pettersson, and others show that considerable importance must be attached to this factor in any determination of the physical influences at work in the North Sea basin. It is all the more regrettable that there exists no permanent organisation in this country which is adequately equipped for the task of investigating the state of the sea from year to year, and that such temperature data as are collected at coast stations and on board ships are not summarised and published as regularly (if not so frequently) as the observations made through the Meteorological Office upon the state of the atmosphere. Water-temperature, salinity, and the movements of great water-masses have relations to the fisheries which are at least as intimate as the relations to agriculture of air-temperature, rain, and the course of the air-currents.

These considerations show the necessity of caution in comparing the results of the fisheries in particular years, or for short terms of years; and considerable latitude must be allowed for temporary fluctuations attributable to the effects of the weather, even if, with our present incomplete knowledge, we are unable to state confidently what the precise effect of any given type of weather has been upon the various species of fish, except, perhaps, in years of unusual severity or warmth.

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* The temperature of the deeper water offshore immediately prior to the breeding season must also affect the metabolism of fishes, and probably, therefore, their fecundity.

The complaint of the fishermen, however, for many years past has been that the bottom fisheries have been annually and steadily diminishing in return for the same labour expended upon them; and, so far as the abundance of flat-fish alone is concerned, this view was adjudged correct by the Select Committee of the House of Commons which sat in 1893.

Professor McIntosh has recently expressed his dissent even from this conclusion, and in a remarkable book* boldly adopts the view that man's operations and the means of capture at his disposal are insufficient to affect the perennial abundance of sea-fishes. He says (pp. 239, 240): "A calm survey of the situation shows that the cry concerning the annual diminution of our fish-supply has been dispelled by the institution of statistics; that the alleged destruction of spawn has no basis in fact; that the destruction of immature fishes is common to all classes of fishermen, and nowhere is proved to have resulted in the ruin of any sea-fishery; that because the first five years of the decade 1886–95 had a higher average than the second in the Fishery Board's experiments, it therefore followed that diminution of the fishes had occurred, and called for further closures beyond the three-mile limit to remedy it, is shown to rest on insecure data; that the closure of the three-mile limit has failed to increase the number or the size of the food-fishes, is ineffective in regard to the supply of the public, and is a continual source of friction and expense, while falling short of the expectations of those who clamoured for it; that the evidence given before the Trawling Commission of 'trawling out' certain grounds in three years with a small vessel carrying a small trawl, the working period being about three days a week for three months in autumn, is at variance with experience; that the statements to the effect that fishes captured by the trawl are inferior as articles of food to the general public cannot be maintained either by science or by a knowledge of the markets; that the *Garland's* work shows the comparatively small destruction of immature fishes of value, even though she often trawled where no commercial ships would; that the perusal of masses of fishery statistics shows the constant series of changes that take place on every area, yet the fisheries are not destroyed; that such a fishery as that for sparlings in the estuary of the Tay has from time immemorial been very much as it is; that though salmon and sea-trout abound in the sea, men derive little knowledge of their presence by either trawl or hook, and yet many of both must come in their way."

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* *The Resources of the Sea.* London, 1899.

Again, "The returns from the various centres all over the country have for the most part steadily increased since 1884, and though it is true that large quantities are captured on the Great Fisher Bank, Iceland, and other regions at a distance from British waters proper, yet this is due to the more remunerative nature of the work, and not to the dearth of fishes in the seas at home" (p. 241).

The foregoing quotations indicate sufficiently the general tenor of Professor McIntosh's conclusions. Some of these may be readily granted, but the most important ones, which deny the alleged impoverishment of the older fishing grounds, and even the possibility of depleting them by human interference, are, as the Professor admits, "so different from the oft-repeated views and wide-spread opinions of the fishing community and the public," that I have felt the necessity of making an independent examination of the evidence upon which the Professor relies, as well as of the evidences bearing on the English fisheries, which do not appear to have so seriously engaged his attention. These evidences have not hitherto been brought together in any form convenient for reference, so that even if my conclusions should contain any elements of uncertainty, the collation of the scattered data should at any rate serve a useful end.

One claim, however, is made by Professor McIntosh, which, though it would not affect the decisions of scientific men, is likely to unduly bias the opinions of the public in the direction of the Professor's views, viz. his claim of a similarity between his own conclusions and those reached by the late Professor Huxley "from a totally different standpoint" (preface, p. x.; text, pp. 234, 235).

Had Professor McIntosh claimed a resemblance between his views on the inexhaustibility of the bottom fisheries and Professor Huxley's on the inexhaustibility of the surface fisheries, no objection could be raised to the comparison; but the implication (however unintentional) in the preceding paragraph is clearly that Professor McIntosh's views on the trawl fisheries are more or less identical with those entertained by Professor Huxley concerning the same fisheries, although arrived at by different modes of reasoning. Professor Huxley's opinions on matters connected with the sea fisheries are deservedly held in high esteem—whether from the thorough character of his inquiries, or from the liberality and independence of his judgment; but the views which Professor Huxley expressed on the inexhaustibility of the fisheries are characterised by his usual precision of language, and cannot be construed as referring to the bottom fisheries in general.

After admitting that a salmon fishery (and all river fisheries) can be exhausted by man, because man is, under ordinary circumstances, one of the chief agents of destruction, Professor Huxley asks, Does the same reasoning apply to the sea fisheries? Are there any sea fisheries which are exhaustible? He replies, "I believe that it may be affirmed with confidence that, *[*] in relation to our present modes of fishing,* a number of the most important sea fisheries, such as the cod fishery, the herring fishery, and the mackerel fishery, are inexhaustible. And I base this conviction on two grounds—first, that the multitude of these fishes is so inconceivably great that the number we catch is relatively insignificant; and, secondly, that the magnitude of the destructive agencies at work upon them is so prodigious that the destruction effected by the fisherman cannot sensibly increase the death-rate" (International Fishery Exhibition, London, 1883, Inaugural Meeting of the Congress, Report, p. 14).

It is clear from this passage and the context that Professor Huxley limits his conviction as to the inexhaustibility of sea fisheries to the drift-net fisheries of all kinds, and to the cod fishery as it was then pursued by means of lines and hooks. He expressly excludes the remaining sea fisheries from the category to which his conviction refers, for, after giving illustrations in support of the conviction just quoted, he continues: "There are other sea fisheries, however, of which this cannot be said. . . . Theoretically, at any rate, an oyster-bed can be dredged clean. In practice, of course it ceases to be worth while to dredge long before this limit is reached. . . . Thus I arrive at the conclusion that oyster fisheries may be exhaustible. . . . *I have no doubt that those who take up the subjects of trawling and of the shell fisheries will discuss the question in relation to those fisheries*" (*l.c.*, pp. 16, 18).

Professor Huxley's views on this important question have been so widely misunderstood that I am glad to have the present opportunity of reiterating his actual statements, and the limits within which he expressly intended them to apply. If I may go a step further than Professor Huxley's words authorise as forming part of his personal opinions, it will be to point out that far the most valuable, and formerly the most abundant item in the produce of the trawl fisheries, is the catch of flat fishes; and that, from their relatively sedentary habits of life, their permanent location on the sea-bottom in more or less shallow water, and the methods adopted for their capture, these fishes more nearly approximate to the oyster, as regards the conditions of their exhaustibility, than to the mackerel, herring, or even the cod-fish tribes.[†]

I have, moreover, no hesitation in affirming that, as regards the relative influence of the various destructive agencies upon the death-rate of flat fishes, the destruction directly effected by man far exceeds the destruction wrought by other enemies. These are practically limited to gulls and the more rapacious members of their own tribe

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[*] The italics are mine. [†] Cf. *Report of Trawling Commission*, 1885, pp. xxxv., xliii.

(turbot, brill); but the latter may be neglected, since they themselves form an important item in the produce of the same fishery, and their numbers naturally bear a fairly constant proportion to the numbers of the less predatory fishes (by no means limited to flat fishes) upon which they prey. Professor McIntosh concludes that the destruction of immature flat-fish by trawls and other drag-nets may be disregarded, since immature fish of all kinds are destroyed in every mode of fishery without injuriously affecting the supplies. Probably the most considerable destruction of immature fish, other than flat-fish, occurs in the whitebait fisheries on our own coasts, and in the sardine fisheries of France. But there are three excellent reasons why this destruction should have less effect upon the abundance of herrings, sprats, and pilchards than upon the stock of flat-fish—firstly, because the destruction of the former fishes in any given locality is necessarily limited to a small portion of the year, owing to the periodicity in their surface migrations, while the common types of flat-fish, whether young or old, are never removed from the influence of the fisherman's implements of capture; secondly, because first-year herrings and sprats are sought so eagerly by shoals of mackerel, etc., that the destruction wrought by man at this stage can scarcely exceed a small fraction of the total mortality; and thirdly, because the larvæ of plaice, and probably soles, in consequence of their specialised habits, must undergo a heavy preliminary mortality* at the time of metamorphosis, from which herrings, at any rate, are probably exempt. Nature may thus be said to have made provision for a heavy death-toll of young herrings, but not of young flat fish.

The important question, in fact, is not whether some immature fishes may be destroyed with impunity by all classes of fishermen, but whether in any fishery the destruction of immature fish of any particular species is sufficiently great to sensibly increase the death-rate due to natural (*i.e.* non-human) causes. For evidence upon this point I may refer especially to the investigations of my colleague, Mr. Holt, and of Mr. Cunningham, upon the destruction of immature plaice in the North Sea (this Journal, vol. iii. pp. 339–448, vol. iv. pp. 410–4; and vol. iv. pp. 97–143).

In the present paper, however, I do not pretend to do more than analyse the evidence as to whether the bottom fisheries are, or are not, in a stable condition; and, if they are undergoing the process of exhaustion which Professor Huxley regarded as within the bounds of possibility, to attempt to determine at what rate the process of depletion is going on.

Professor McIntosh bases his conclusions upon the alleged failure of the Scottish Fishery Board to demonstrate by their trawling experiments any appreciable change either of decrease or increase in the inshore fisheries, and appeals to the general statistics of the sea fisheries to show that the enormous fecundity of sea fishes and similar causes "enable Nature to cope, in regard to the food-fishes, with all the wonderful advances in apparatus of capture, and with the steady increase of population."

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* Cf. PETERSEN, *Rep. Danish Biol. Station*, IV., 1894, p. 15.

SUMMARY.

I have therefore, in the first place, made an independent examination of the results of the Fishery Board's experiments. It will be seen, in the sequel, that I agree with Professor McIntosh that the methods by which it was sought to demonstrate the observed changes in the fish population of the closed waters were inadequate, and caused the Fishery Board's conclusions to rest upon an insecure basis; but after eliminating all sources of uncertainty in the methods, I find that the changes in the fish fauna, which were especially emphasised by Dr. Fulton, are capable of abundant verification. There appears to me to be no further room for doubt that during the ten years' closure of St. Andrews Bay and the Firth of Forth against trawlers, there was a decrease of plaice in the closed waters of both areas, and a marked increase of common dabs; and that in the Forth lemon soles markedly decreased, and long rough dabs increased. These latter species are too scarce in St. Andrews Bay to be worth considering in respect to that area. I concur with Dr. Fulton that the decrease of plaice and lemon soles, in spite of the protection inshore, is most probably to be attributed to the effects of over-fishing by trawlers on the offshore grounds, which causes, as one of its results, a great reduction in the quantity of eggs by which alone the stock of these fish can be maintained, whether on the inshore or offshore grounds. I also agree in part with Dr. Fulton that the increase in dabs and long rough dabs may be attributed to some extent to the protection of the inshore spawners of these species; but am inclined to attribute a certain and probably a large portion of the increase to the advantage conferred on the dabs by the reduced numbers of their competitors, the plaice and lemon soles. The reported increase of dabs and long rough dabs outside, as well as inside, the closed waters tends to support this view.

In the second place, I have endeavoured to make a fairly exhaustive analysis of all the available statistics, official and unofficial, which deal with the English fisheries. They consist of the following separate items:

1. The actual annual catches of Grimsby sailing trawlers for a nearly continuous period of thirty-three years, from 1860 to 1892 (supplied by Grimsby smack-owners).

2. The weight of fish annually sent inland by rail from the port of Grimsby, compared with the numbers of fishing vessels, both sailing

and steam, registered at the port, from 1886 to 1899 (from returns provided by the Great Central Railway Company).

3. The weight of fish annually landed by trawlers at the Lowestoft fish-docks, from 1883 to 1898, compared with the gross number of trawling vessels landing at the port (from returns provided by the Great Eastern Railway Company).

4. The total weight of bottom fish annually landed on the various coasts of England and Wales during the decade 1889 to 1898, compared with detailed estimates of the number and catching power of the deep-sea trawlers and liners during the period (from the Board of Trade returns and numerous other sources specified below).

The results obtained from all these various independent sources of information display a melancholy unanimity. Whatever the period—whether ten years or thirty years—and whatever the extent of the fishery—whether the smack fisheries of Grimsby and Lowestoft, the general fisheries of Grimsby, or the entire bottom fisheries of England and Wales, either as an entirety or according to the seas frequented—the average return for each vessel engaged in the fishery, or for each equivalent unit of fishing power, is shown to fall from year to year with none but insignificant fluctuations in the rate of fall.

We have, accordingly, so far as I can see, to face the established fact that the bottom fisheries are not only exhaustible, but in rapid and continuous process of exhaustion; that the rate at which sea fishes multiply and grow, even in favourable seasons, is exceeded by the rate of capture. The rate of exhaustion is shown to be different for different species of fish. The more valuable flat fishes, plaice and prime fish, show the most marked signs of diminished and diminishing abundance. These differences should obviously be noted, and if possible still further elucidated, in order that the difficulties in the way of remedial measures may be intelligently anticipated and met.

In conclusion, it is with much pleasure that I acknowledge the assistance which I have received in the preparation of this paper from numerous individuals and official representatives, without whose cooperation it would have been impossible to undertake certain parts of this revision of the fishery statistics on anything like so extensive a scale. To Mr. G. L. Alward, of Grimsby, I am under a particular debt of gratitude, not only for the information placed by him at my disposal, but for the frequency with which he has sacrificed time and labour, probably at great personal inconvenience, to respond to my inquiries. I have also been aided by Mr. W. E. Archer, H. M. Inspector of Sea Fisheries, and his colleagues at the Board of Trade; by Mr. J. W. Towse, Clerk to the Fishmongers' Company; by the General Managers of the Great Central and Great Eastern Railway

Companies; the Manager of the Milford Docks Company; Commander Scobell Clapp, R.N., Queen's Harbourmaster of Holyhead; the Harbourmasters of Neyland, Newlyn, Ramsgate, and Lowestoft; Mr. Sanders, of Brixham; Mr. Shepherd, of Plymouth; Mr. B. J. Ridge, of Newlyn; Mr. J. W. Turner, of Lowestoft; Mr. R. L. Ascroft, of Lytham; Mr. W. H. Ashford, Fishery Officer of the North-Eastern Sea Fisheries Committee, Scarborough; as well as by other gentlemen, the results of whose assistance do not directly appear in the present communication. I desire to express my cordial thanks to all who have co-operated with me in the work.

If errors, either great or small, should be detected in my methods or calculations, I am alone responsible for them; but I trust that they will be found to be neither numerous nor serious. So far as the methods are concerned, I have endeavoured throughout to base the conclusions as far as possible upon grounds which are capable of verification, and in matters where absolute precision was unattainable, to steer a moderate course in the estimates adopted.

The Experimental Evidence.

The scientific evidence which bears upon the alleged depletion of the trawling grounds is necessarily limited, since neither the Fishery Board for Scotland nor the Marine Biological Association has been enabled to carry out prolonged researches upon the deep-sea fishing grounds. Nevertheless, the experiments made by the Scottish Fishery Board in closing certain areas off the Scottish coasts against trawling operations have a distinct bearing upon the question. It was alleged that these areas, as well as other inshore waters, had been depleted of fish as a consequence either of general over-fishing or of the excessive destruction of immature fish by trawlers. It was consequently expected that the protection of these large areas for a term of years against the ravages of trawlers would result in their gradual recovery and in an increase in the quantities of fish upon the grounds.

The areas were closed against trawlers in 1886, and during the following ten years experimental trawlings within the closed and open areas were conducted by the Fishery Board at frequent intervals, in order to obtain a record of the changes induced by the prohibition of trawling. It is clear that any general increase in the stock of fish that could be definitely attributed to the prohibition of trawling would also furnish a practical proof of the extent to which over-trawling had previously reduced the productiveness of the same grounds.

Moreover, the experiments bear indirectly upon the subject of the present inquiry from the fact that they constitute the first extensive experiment on a scientific basis for determining whether it is possible or not by human interference to materially influence the productiveness of a considerable arm of the sea.

It is well known from Dr. Fulton's review of the experiments (*Fourteenth Annual Report of the Scottish Fishery Board*) that, contrary to expectations, "no very marked change took place in the abundance of the food-fishes generally, either in the closed or open waters of the Firth of Forth or St. Andrews Bay," as a consequence of the prohibition of trawling. Nevertheless, among flat fishes a distinct change was reported to have ensued in the relative abundance of certain kinds. Plaice and lemon soles were reported to have decreased in abundance in all the areas investigated, whether closed or open, while dabs and long rough dabs were reported to have shown a preponderating, if not quite universal increase.

This change in the relative proportions of plaice and dabs was explained by Dr. Fulton as principally due to the fact that the protected waters enclosed a considerable area of spawning ground for dabs and long rough dabs, but not for plaice and lemon soles, which spawn exclusively offshore. Moreover, while all four species were subjected to capture by trawlers outside the closed waters, the smaller size of dabs and long rough dabs at maturity would enable many adult and all immature dabs of both kinds to escape through the meshes of the trawl; whereas all mature and a considerable number of immature plaice and lemon soles entering the trawl would be captured. Thus the alleged increase of dabs and long rough dabs was attributed by Dr. Fulton principally to the beneficial effects of the protection of their spawning grounds, while the continued decrease of plaice and lemon soles was attributed to excessive destruction of adults and young of both species in the open sea.

Dr. Fulton accordingly draws the following main conclusions from his examination of the results of the trawling experiments: (1) that the mere closure of even large areas in the territorial waters which are destitute of spawning grounds is of little practical benefit to the inshore fisheries, and (2) that the most likely method of benefiting the inshore fisheries would be to protect the offshore spawning grounds for certain periods in the year.

Professor McIntosh, however, entirely rejects the conclusions drawn in this report, together with the figures upon which the conclusions were based, principally on the ground that the statistical methods by which the results were attained are vitiated by an important error. Dr. Fulton divided the ten years into two quinquennial periods, and contrasted the average catches per haul of the trawl during the first period with those made during the second. Professor McIntosh points out that during the first period there was a preponderance of hauls during the summer or productive months, whereas during the second period the preponderance of hauls fell in the winter or comparatively unproductive months. The validity of the criticism is borne out by the official figures; but whether the error caused by these differences alone is sufficient to invalidate the whole of Dr. Fulton's conclusions is rendered very doubtful by the contrast which Dr. Fulton emphasised between the decrease of one group of flat fishes and the increase of the other. The error might account for the decrease in plaice, but how can it also account for the increase in dabs?

Professor McIntosh does not, however, directly controvert the statement that plaice and lemon soles did, as a matter of fact, decrease in numbers, and that dabs increased; unless we construe in this sense his remarks that the average catch of plaice in the Forth was higher in 1895 than in 1886, both for the colder and warmer months (*Resources*, p. 167). But in the last Report of the Fishery Board (for 1898) Dr. Fulton gives a new summary of the results, based upon a comparison of corresponding cold and warm periods, and concludes that "the same result (*i.e.* decrease of plaice and increase of dabs) is found, whether the whole year is contrasted in the two quinquennial periods, or the warm months against the warm months or the cold months against the cold months." He provides, also, a table of averages for the two quinquennial periods, to show that "the change in the relative abundance of the offshore-spawning plaice and lemon soles, and of the inshore-spawning dabs, was common to almost every month of the year." A decrease of plaice and lemon soles is observed for every month except January, July, and December; and an increase of dabs and long rough dabs for every month except August. It is also shown that during the first period plaice and lemon soles together were more numerous than dabs in every month except December; whereas in the second period dabs assumed the preponderance in six months out of the twelve, *i.e.* from June to December with the exception of July. Dr. Fulton reiterates his conclusion that the "inshore-spawning dabs, therefore, to a very large extent supplanted the offshore-spawning plaice and lemon soles in the closed waters."

The sequence of figures submitted in further support of this conclusion is undoubtedly impressive, and would have set the question at rest if the monthly averages for each quinquennial period had all been equally reliable. But the admitted irregularity of the *Garland's* experiments, especially in the earlier years of the decade, prevented anything like a monthly survey of the experimental areas in successive years. Accordingly, the monthly averages submitted by Dr. Fulton are not based upon a uniform set of data, and there is nothing in the new summary to show which of the averages may be taken as reliable, and which are based on an insufficient series of observations. As the figures ostensibly represent the average conditions prevailing during periods of five years' duration, it is manifestly impossible to regard any of them as satisfactory which are based on the surveys of one or two years only in each period, especially if the years fall exclusively near the middle of the decade. The averages for the second period may be accepted as thoroughly satisfactory, so far as the number of years is concerned; but in the case of the first period the averages for January, February, March, and possibly December, may justly be discredited, either on account of the insufficiency of the number of years represented by the averages (January—one year only), or by the fact that the two years included are limited to the latter portion of the period (February and March, 1889 and 1890; December, 1888 and 1890).

Four of the monthly averages out of the twelve are thus eliminated upon merely preliminary examination of the data upon which they are based. Further scrutiny shows that an equally serious objection may be urged against several of the remaining averages, owing to the unequal representation of the two areas in the combined averages. The great differences between the Firth of Forth and St. Andrews Bay in regard to the seasonal abundance of the different kinds of flat-fish render it imperative that in any combination of the averages for comparative purposes the two areas should be represented in equal proportions during the two periods. Yet during the second period, while the Forth was investigated with almost perfect regularity month by month during the successive years, there are four months (January, May, August, and September) in which no examinations whatever were made in the Bay for four years out of the five. For these months, therefore, during the second period, the influence of the Forth largely predominates in the "averages"; whereas during the first period the Bay and the Forth were equally represented, so far as the number of surveys is concerned, in three out of the four months (viz. January, May, and August). On this count, therefore, the January averages are still further discredited, and we are also forced to add May and August to the list of unreliable averages, which brings the total up to six out of the twelve.

That the fallacy caused by disproportionate representation of the two areas in the two quinquennial periods has led to errors of an appreciable and serious character may be judged from the following figures. They represent approximately the average number of fish of the different kinds distinguished taken in one haul of the trawl in each month of the year in the closed waters, the numbers for St. Andrews Bay being kept distinct from the numbers for the Firth of Forth. They are based on the "monthly averages per shot" published in the annual reports of the trawling experiments, and are the mean of those averages for the entire decade, except that fractions of the resultant figures are here omitted, and that the averages for the first two years in the case of dabs have been independently worked out, since for those years the official averages for dabs and long rough dabs were not distinguished.

TABLE I., *showing Average Number of Fish per Haul of the Trawl for each month of the year in the closed waters of St. Andrews Bay and the Firth of Forth respectively (from the ten years' experiments of the "Garland")*.

	ST. ANDREWS BAY.				FIRTH OF FORTH.			
	Plaice.	Lemon Soles.	Dabs.	Long Roughs.	Plaice.	Lemon Soles.	Dabs.	Long Roughs.
January .	6	0	1	1	26	3	6	16
February .	13	0	5	1	38	3	8	16
March . .	56	0	9	0	35	5	17	20
April . .	81	0	21	0	42	16	25	17
May . .	89	0	70	1	42	18	29	20
June . .	149	0	121	2	56	25	42	17
July . .	*122	0	55	1	56	25	69	24
August .	303	0	209	1	79	33	69	28
September .	140	0	177	4	60†	28	77	25
October .	120	0	69	1	55†	15	46	23
November .	65	0	57	0	31	8	19	22
December .	3	0	11	1	21	4	13	23

It will be seen from these figures that the average catch regularly increases or diminishes in numbers with the sequence of the months. The only serious discrepancy is in the St. Andrews averages for July, the low value of which is entirely due to the insufficient number of observations made in this month (only three surveys in the ten years), and to the accident that the surveys which actually were made fell in relatively unproductive years. Had surveys been also made in this month in the year 1887, and in either 1890 or 1895 (as was the case with the June and August surveys), it is perfectly clear upon examination that the averages for the month would have been intermediate in value between those of June and August.

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* The figures for July, 1886, have been altogether omitted for St. Andrews Bay, owing to the incomplete examinations made of the stations in that month.

† September and October, Firth of Forth.—In 1886 five of the seven Forth stations were surveyed in September, the remaining two stations in October. The data have therefore been merged together in my table under September, and altogether excluded from October. In the official report on the first year's work, the September and October averages are based on the partial data of the stations examined in each month respectively; but as the figures for the most productive station (No. II.) are thereby omitted from the October data this separation can scarcely be approved.

Nothing could illustrate more forcibly than this table the great differences between the two areas as regards the influence of the seasons upon their productivity. The changes in the abundance of each species are relatively slight in the case of the Forth, but are exceedingly great in St. Andrews Bay. In the Forth the maximum summer average is not four times the minimum winter average in the case of plaice, nor elevenfold in the case of dabs; but in the Bay the maximum abundance in August exceeds the minimum abundance in December a hundredfold in the case of plaice, and even two hundredfold in the case of dabs. The monthly catch of plaice in St. Andrews Bay exceeds that in the Forth for each month of the year except December, January, and February, the degree of excess rising to fourfold in the height of the summer (August), and falling away to three- and two-fold towards the earlier and later months of the year. In the three winter months, on the other hand, the catch in the Forth exceeds the catch in the Bay by as much as three, four, or seven fold. The figures for dabs present the same general features, but the excess of the summer catches in the Bay over those in the Forth is not quite so great, and the winter excess of the Forth catches over those in the Bay is shown in five instead of three months only.

With these facts before one, which refer, it must be remembered, exclusively to the closed waters under discussion, it is easy to forecast the general effect of combining the statistics of the two areas. With a perfectly equivalent number of hauls the monthly average of the combined areas will assume a mean character intermediate between the average for the two areas taken separately; but any deviation from strict equivalence will raise or lower the combined average to an extent depending on the nature of the seasonal differences between the two areas for the month in question. Thus for April the combined average for plaice would be 61 upon an equivalent number of hauls from the two areas; but if two hauls in the Forth were combined with one in the Bay the average would be reduced to 55; and if the hauls in the Bay preponderated over those in the Forth to the same extent the combined average would be raised to 68. For August the changes introduced would be still greater; with equivalent hauls the combined average would be 191; with two hauls in the Forth to one in the Bay it would be reduced to 154; with two in the Bay to one in the Forth it would be raised as much as to 262. Consequently, monthly averages based on quite irregular combinations of hauls in the two areas are fallacious and misleading, and it is quite impossible to judge of the effect of the closure of the Scottish bays from figures calculated upon this basis.

Yet, if a table be drawn up setting forth the yearly frequency of the monthly surveys actually carried out in the two areas, it will be seen at once that, with the single exception of June, the proportion which the number of surveys in either area bears to that in the other area for the first quinquennial period is never exactly repeated for the second quinquennial period—a lack of co-ordination which necessarily biases the combined averages and precludes any exact comparison between the two periods by the methods which Dr. Fulton has pursued. Thus for January the average from one year's survey in St. Andrews Bay and one in the Forth in the first period is contrasted with the average derived from one survey in the Bay and five surveys in the Forth during the second period. For February the average for the first period is based exclusively on surveys in the Forth, and this is contrasted with an average for the second period derived from four surveys in the Bay and five in the Forth. For March the average is derived from two surveys from each area in the first period, but from a combination of three St. Andrews surveys with four Forth surveys in the second, and so on, the general tendency being to give the Forth a preponderating influence on the combined averages, which is considerably greater during the second period than the first. The only exceptions are June, in which the proportion of surveys in the two areas is the same in the two periods, and February, July, and November, for which months the Bay exercises a greater influence on the averages for the second period than for the first.

Leaving these exceptional cases out of consideration for a moment, we may trace the general tendency of this excessive influence of the Forth on the averages for the second period by reference again to the data contained in Table I.

In the case of plaice, owing to the productivity of the Forth in this species being much lower than that of St. Andrews Bay for all except the three winter months, there can be no doubt that a preponderating influence of the Forth on the combined averages for the second quinquennial period must tend, *ceteris paribus*, to depress the average for plaice below its value for the first period, thus fallaciously producing an appearance of a diminution in the numbers of plaice in the combined areas, even when no such diminution may be apparent from the figures for the two areas taken separately.

If lemon soles are added to plaice, as in Dr. Fulton's last figures, such inclusion will not materially affect the figures for St. Andrews Bay, but will increase those for the Forth to an appreciable extent in the summer months; but even under these circumstances the Bay maintains its greater productivity for the same number of months as for plaice alone.

Of the months* in which the influence of St. Andrews Bay on the averages is greater for the second period than for the first, it will be noticed that February is one of the three exceptional months in which plaice and lemon soles are less abundant in the Bay than in the Forth. Consequently, the fall in the combined average catch of these fishes, when the two periods are compared, is again explicable merely from the fallacy latent in the disproportionate combination of the statistics of the two areas. The July averages are exceptional in showing an increased catch in the second period compared with the first. This feature also may be directly attributed to the increased influence of the Bay in the second period. In November alone is the verdict of the averages at variance with the tendency caused by the increased influence of the Bay during the second period—an exception which can be conclusively traced to an altogether exceptional catch of plaice in St. Andrews Bay in 1889. The average haul of plaice in November, 1889, in the Bay, amounted to 213 fishes. The average for the four other years during which surveys were made in the same month were 38, 47, 16, and 10 respectively, and only one of these fell in the first quinquennial period. Had observations been also made in the five remaining years, no doubt the abnormal difference in the averages for the two periods caused by the exceptional catch just mentioned would have been reduced to juster proportions.

There is, therefore, no escape from the conclusion that *the combination of the figures for the Forth and the Bay is sufficient in itself to account for decreased averages for plaice and lemon soles in the second period as compared with the first.*

As regards the reported increase of dabs and long rough dabs, the same argument holds to a considerable extent. It has already been pointed out that the disproportion between the Bay and the Forth is less in the case of dabs than in the case of plaice. This is particularly so if dabs and long rough dabs are grouped together, since the scarcity of the latter in the Bay, and their relatively large numbers in the Forth, greatly reduce the difference which exists between the two areas in regard to the relative abundance of common dabs alone. It can be seen from Table I. that in the closed waters dabs and long rough dabs together are more numerous in the Forth than in the Bay in January, February, March, April, July, and December. There can be no doubt, as previously remarked, that the July figures for St. Andrews Bay cannot be regarded as strictly accurate, owing to the inadequate number of observations; but the fact remains that, under the conditions of the experiments, the average number of dabs taken from the Forth considerably exceeded the corresponding number from the Bay in six months out of the twelve. It is consequently not surprising, if, owing to the increased influence of the Forth on the averages for the second quinquennial period, there should be displayed a considerable number of months in which the combined averages show an apparent increase in the abundance of dabs.

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* February, July, and November.

I conclude that the figures recently submitted by Dr. Fulton in his new summary of the results of the *Garland's* experiments by no means re-establish the conclusions set forth in his original review. It appears to me that, in consequence of the irregularity of the *Garland's* operations, it is quite impracticable to set up well-founded conclusions upon a basis formed by combining the figures for the Forth and Bay. One or other of these areas, under the conditions of the experiments, must unduly bias the averages, and unless an equivalent proportion is maintained between the monthly surveys in the two areas in each period, the resultant differences between the quinquennial averages must necessarily be fallacious.

Nevertheless, while going even a step further than Professor McIntosh in his criticism of the methods by which the results of the *Garland's* experiments have been set forth, I am quite unable to follow the Professor in his condemnation of the experiments themselves, which would appear from internal evidence to have been well designed and executed. The irregularity of the surveys in the earlier years is much to be regretted, and demands more than ordinary care to be bestowed upon the analysis of the results. But from the impartial and critical examination which I may claim to have made of the published records of the experiments, I am satisfied that the experiments have been largely successful in throwing light on the problem which they were designed to elucidate, in spite of the unfortunate errors of method with which the conclusions have been associated.

It appears to me, under the circumstances of the case, that Dr. Fulton's method of averaging the figures for two quinquennial periods and for the different months of the year is perhaps the best method to adopt in order to obtain a general view of the changes wrought during the ten years of prohibited trawling; although, in view of the small number of surveys made during the first two years and their greater frequency during the last five years, there would be certain advantages in dividing the decade into a first period of six years and a second period of four years. This alternative method would have the effect of increasing the number of monthly surveys in the first period, and thus of rendering valid certain of the monthly averages which, in the quinquennial period adopted, are based upon too small a number of surveys. On the other hand, by adopting such an extension of the first period the averages could be less confidently claimed to represent the condition of the areas immediately subsequent to the prohibition of trawling. But it appears to me to be in any case indispensable that the figures for the Forth and for St. Andrews Bay should be kept distinct, as well as the figures for the different species of fish.

I have therefore prepared a table (II.) of quinquennial averages based upon these principles. The averages are not, it is true, based upon the original numbers of fish taken in each haul of the trawl, but upon the monthly averages per haul of the trawl published in each year's report of the trawling experiments. In the case of St. Andrews Bay the closed area embraced four trawling stations, so that each of the monthly averages published for this area represented usually the mean of four hauls of the trawl. The closed area of the Firth of Forth embraced seven such stations, the monthly average therefore representing the mean of seven hauls. The figures in my table represent the

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TABLE II., *showing the Average Monthly Numbers of Flat-Fish per Haul of the Trawl taken by the "Garland" in the closed waters during each quinquennial period, distinguishing the different areas and the different kinds of Fish.*

ST. ANDREWS BAY.

Plaice.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1st Period .	[9]	—	[63]	[134]	[101]	155	[148]	368	[120]	137	[126]	[4]
2nd ,, .	[3]	13	51	46	[64]	145	[108]	[42]	[179]	98	36	5

Dab.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1st Period .	[1]	—	[5]	[13]	[72]	135	[81]	249	[149]	39	[24]	[7]
2nd ,, .	[1]	5	12	26	[65]	135	[42]	[48]	[254]	108	[80]	13

FIRTH OF FORTH.

Plaice.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1st Period .	[14]	[46]	[33]	44	[28]	60	64	95	71	61	28	[7]
2nd ,, .	28	35	36	40	49	53	66	62	54	51	35	27

Lemon Sole.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1st Period .	[1]	[1]	[4]	18	[17]	32	31	37	35	17	11	[3]
2nd ,, .	4	4	6	14	18	19	28	30	23	14	5	5

Dab.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1st Period .	[3]	[3]	[11]	20	[15]	37	65	49	54	42	14	[13]
2nd ,, .	7	10	20	29	35	47	73	94	90	49	25	14

Long Rough Dab.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1st Period .	[10]	[6]	[13]	12	[22]	16	21	23	18	21	20	[12]
2nd ,, .	17	20	23	19	19	18	25	32	32	24	24	28

means of these averages for the respective periods. They are, therefore, not strictly correct as averages of the entire number of fish taken in the respective months; but the deviations due to the method are of a minute character and do not affect the general results, especially if a margin of several units in the resultant averages is allowed to cover the errors of method and experiment. As the monthly averages for dabs and long rough dabs were not officially separated during the first two years, I have calculated them anew from the details of the monthly surveys for those years; and the same alterations have been made in regard to the monthly averages for 1886 as were described in the footnotes to Table I., p. 13.

I have, moreover, placed in brackets all such averages as are based on less than three surveys in each quinquennial period. This precaution shows at a glance which of the averages may be depended upon as accurately representing the general condition of the fauna during the corresponding period. The method falls rather severely upon the averages for St. Andrews Bay, but the natural fluctuations in that area, due to its shallowness and exposed situation, are so great that no less rigorous method could be safely relied upon to eliminate the irregularities due to these circumstances.

For **St. Andrews Bay** the two quinquennial averages are seen from the table to be reliable in only two months out of the twelve, viz. June and October. They show in each case a fall in the abundance of plaice, correlated with an equality or a marked rise in the number of dabs. The change for June is seen to have been slight; but for October a great predominance of plaice over dabs in the first period is replaced by a superiority of dabs over plaice in the second period.

I have not included any statement of the averages for lemon soles and long rough dabs in connection with this area, owing to the great scarcity of these forms in the Bay as shown by Table I.

For the **Firth of Forth** seven months out of the twelve are seen to afford reliable averages for each period, viz. April to November inclusive, with the exception of May. The differences between the quinquennial averages are not great, except for August; but it is certainly noteworthy that the general tendency of the change is in the same direction as in the case of St. Andrews Bay.

The averages for plaice decrease in five months out of the seven, by amounts which vary between 9 per cent. and 33 per cent. The two increased averages show a rise of 3 per cent. and 25 per cent. respectively.

The averages for lemon soles show a decrease in every one of the seven months; whereas the averages for dabs and long rough dabs respectively show an increase in every month.

In spite of all that has been said as to the inadequacy of the *Garland's* experiments for yielding a scientific verdict on the effects of the prohibition of trawling, there appears to me to be only one possible conclusion from the foregoing figures; viz. that there was a general diminution both of plaice and lemon soles in the closed waters after the prohibition of trawling, and a still more marked increase in the abundance of dabs and long rough dabs.

It must be remembered that whatever irregularities occurred in the *Garland's* work as to the duration of the hauls of the trawl and such matters, these necessarily affect the figures for all species of flat-fish alike. The contrast remains that, under precisely the same experimental and climatic conditions, plaice and lemon soles are seen to have decreased, and dabs and long rough dabs to have increased during the decade.

Dr. Fulton's conclusions are, therefore, in all respects correct, so far as I am able to determine, and are independent of the errors which were associated with his methods of demonstration.

Under these circumstances I see no reason for disputing Dr. Fulton's principal explanation of the changes which were induced in the relative abundance of flat fishes in the closed waters during the period of prohibited trawling. It appears to me to be reasonably established that *pari passu* with the increased destruction of plaice and lemon soles in the open waters, there has been a progressive diminution of these fishes even in inshore waters which have been continuously protected from the effects of trawling operations. It also appears to be satisfactorily demonstrated that under the conditions just mentioned a conspicuous increase in the abundance of dabs and long rough dabs has taken place in the inshore waters.

Nevertheless, it is certainly open to reasonable doubt whether this increase in dabs has been exclusively, or even mainly, due to the protection of the spawning grounds of these fishes; for the observed increase of long rough dabs is as great as that of common dabs, yet, from their preference for the deeper waters, the long rough dabs cannot have received the same measure of protection as the common dabs from the prohibition of inshore trawling. The possibility should be borne in mind that the increase of dabs may have taken place quite independently of the prohibition of trawling, in consequence of the decrease of plaice and lemon soles with which they may be supposed to be natural competitors—a suggestion previously made by my colleague Mr. Holt, in connection with similar problems on the Devonshire coast (*Jour. M. B. A.*, vol. v., 1898, p. 320). It is obvious that any diminution of the species which normally maintain a rivalry with dabs for the available food supply must confer an advantage upon the dabs, enabling a greater stock of these fish to live on the same extent of ground. Moreover, from their smaller size, there is reason to believe that the numerical increase in dabs would be greater than the numerical decrease of the plaice and lemon soles which they may be held to have supplanted. This explanation derives support from the reported increase of dabs in the open, as well as the closed waters of the regions investigated.

It is, however, sufficient for my present purpose if I have demonstrated that changes have taken place in the abundance of fish in Scottish waters, which are attributable in all probability to the effect of man's operations; the decrease of plaice and lemon soles to the reduced supply of fry caused by the excessive destruction of these species by over-fishing in the offshore waters, the increase of dabs and long rough dabs either directly to the protection of their spawning grounds, or indirectly to the natural consequences, in the struggle for existence, of the reduction in the numbers of their competitors.

THE STATISTICAL EVIDENCE.

I. Annual Catches of Grimsby Sailing Trawlers, 1860-92.

Two Grimsby smack-owners have submitted statements concerning the annual catches of their vessels during the last forty years.

At the request of the Sea Fisheries Commission of 1863, Mr. Henry Knott provided a statement of the weight and value of fish caught by an average Grimsby trawler during the years 1860 to 1864, which is printed as an appendix to the report of the Commissioners (p. 46), and is quoted in Holdsworth's *Deep-Sea Fishing*, 1874, p. 88. The original statement gives the weight in tons, hundredweights, and quarters, and the value in pounds, shillings, and pence. I give below a copy of this statement, omitting unnecessary details, and adding an average of the five years' records.

TABLE III., *showing the Weight and Value of Fish caught by one Grimsby Trawler during the years* 1860 *to* 1864.

(From a Return submitted by Mr. Knott to the Sea Fisheries Commission in 1865).

	Prime. cwts.	Offal. cwts.	Total. cwts.	Prime. £	Offal. £	Total. £
1860 . .	379	1325	1704	320	114	434
1861 . .	262	1396	1658	393	177	570
1862 . .	259	1054	1313	360	106	466
1863 . .	364	1489	1853	455	145	600
1864 . .	458	1888	2346	443	189	633
Average . .	345	1430	1775	394	146	540

It was stated by Mr. Knott that the figures do not refer to the same trawler throughout, but "the selection made in the vessel for each year may be taken as a fair average."

For so short a term of years the annual catches of a single trawler cannot be held to afford much evidence as to the increase or decrease of fish on the fishing grounds within the period. The obvious feature of the table is the abundance and cheapness of fish. Nothing like an average capture of 345 cwts. of prime fish and of 1,450 cwts. of "offal" is realised by trawling smacks at the present time, in spite of the inducements offered by the far higher prices to be obtained to-day for fish of all kinds. The average prices yielded by the figures in the table are 22*s.* 10*d.* per cwt. for prime, and 2*s.* 1*d.* for offal fish. In 1898 the average values, as given in the Board of Trade returns, were £4 17*s.* 11¾*d.* per cwt. for prime fish, £1 4*s.* 5*d.* per cwt. for plaice, and 11*s.* 8¼*d.* per cwt. for haddock. It must be remembered that plaice and haddock in 1860 formed the bulk of the "offal" in a trawler's catch.

The second series of returns of the annual catches of trawling smacks was submitted, in condensed form, to the Select Committee on Sea Fisheries in 1893 by Mr. G. L. Alward, of Grimsby, but the returns themselves were not handed in to be printed in the report. Mr. Alward has, however, kindly allowed me to examine his returns, and as they bear internal evidence of general reliability, and provide most valuable information on the past condition of the Grimsby fishery, I have obtained Mr. Alward's consent to publish a copy of them in the present paper (Tables A–D, pp. 65–6). The only deviations from the original manuscripts consist in the omission of shillings and pence in the values and of fractions of hundredweights in the weights assigned, and in the correction of a few unimportant arithmetical errors in the totals.

The figures represent the actual annual catches of four Grimsby trawling smacks (the names of which are given at the head of each table) for a term of eighteen years, from 1875 to 1892, together with the values realised at the port of landing. The catch of each vessel is divided into Plaice, Haddock, Prime, and Rough. Mr. Alward informs me that "prime" here includes soles, turbot, and brill, and excludes lemon soles; while "rough" includes lemon soles, dabs, cod, catfish, rokers (rays), and other sundry items not specially distinguished.

The vessels were engaged on the various fishing grounds of the North Sea, from the Fisher Bank as the northern limit, to the Lemon and Ore Shoals as the southern limit, and from the grounds off the Yorkshire and Lincolnshire grounds on the west to the Dutch and German coasts on the east.

The vessels formed part of the Grimsby fleets during the summer of each year, but fished independently during the winter. Previous to 1882 they generally commenced fleeting in April or May, and left off in August or September. In 1882 and 1883 there was a general extension of the fleeting period on a more complete system, which lasted from March to the end of October. But in 1883 a general strike occurred at Grimsby against the new system, and the period of fleeting was in dispute. After 1883 fleeting commenced, as before, in April or May, and lasted till August or September. Thus the duration of the fleeting period varied between four and six months in all years except 1882 and 1883, when it was prolonged to about eight months.

It will be seen from the returns in the detailed tables that, however variable the catches of the vessels were from year to year, there was a remarkable uniformity, with few exceptions, in the individual catches for the same year. This circumstance enables us to attach considerable importance to the evidence which they furnish for the whole term of years as to the abundance of fish on the grounds frequented, although undue weight should not be attached to the figures in comparing individual years with one another, owing to the inevitable fluctuations in the catches of sailing vessels dependent so largely upon wind and weather, which would affect the duration of the fleeting period as well as other elements in their catching power.

The figures representing the quantities of fish landed by all four vessels have been combined and averaged in the following table. Figures showing the maximum catch for the entire period, as well as increases in the annual catch, have been thrown up in blacker type in order to distinguish the years of greatest abundance and of increasing returns. I have also, for comparison, prefixed to the series the figures which Mr. Alward had also prepared to show the average catch of his vessels in 1867.

There does not appear to be any need to dwell at great length upon the meaning of these figures, which, except for the sudden rise in 1882, caused by the reorganisation of the fleeting system already described, show a practically continuous fall in the average annual catches. The amount of the total fall, after all possible allowances for variations due to wind and duration of the fleeting period, cannot be placed at less than one-half of the catch obtained at the beginning of the period; while the catch of plaice at the end of the period is scarcely more than one-third of that obtained at the beginning. Rough fish, on the other hand, show a distinct increase up to the last five or six years of the period, when they also begin to show signs of diminishing abundance. The explanation of this contrast is doubtless to be sought in the increasing scarcity of better fish and the advancing prices of all kinds of fish owing to the increased demand. There is abundant evidence in the reports of the various Sea Fishery Commissions that in the palmier days of the trawling industry large quantities of the less valuable fish were thrown away at every haul to leave room for a greater quantity of the better kinds. Conditions have changed in more recent times, and the fisherman, under ordinary circumstances, brings home all he can catch. The increase under "rough" fish is, therefore, evidence rather of an increased attention to the less valuable kinds than of an increased abundance. The catches of haddock fluctuate considerably, as is natural with so migratory a fish; but there can be no doubt, even in this case, as in that of prime fish, that a greater abundance was maintained in the earlier part of the period than in the later years.

TABLE IV., *showing the Average Annual Catch* (*in cwts.*) *of four Grimsby trawling smacks*, 1875 *to* 1892.

	Plaice.	Haddock.	Prime.	Rough.	Total.
1867	998	831	137	46	2012
1875	549	937	63	30	1565
1876	601	891	50	33	1576
1877	421	668	88	21	1198
1878	254	481	76	31	843
1879	298	488	98	44	928
1880	291	359	65	39	754
1881	242	280	84	70	675
1882	385	717	84	86	1273
1883	340	665	97	74	1177
1884	325	526	96	79	1025
1885	280	477	90	89	936
1886	250	510	77	87	925
1887	221	475	62	87	846
1888	195	372	42	57	667
1889	177	342	64	69	652
1890	205	465	47	65	783
1891	203	590	47	79	920
1892	168	436	29	49	683

The following summary shows the average annual catch during successive periods of five years' duration.

TABLE V., *showing a Quinquennial Summary of the preceding table.*

	Plaice.	Haddock.	Prime.	Rough.	Total.
1875–9	425	693	75	32	1222
1880–4	317	509	85	70	981
1885–9	225	435	67	78	805
1890–2	192	497	41	64	795

If these figures be compared with those advanced by Mr. Knott for the years 1860 to 1864, the fall in the annual catches becomes still more striking, whether prime fish alone or the total catch be considered. The return provided by Mr. Alward for 1867 forms a connecting link between the two series, and shows that there is no ground for discrediting the results of a comparison between them.

The explanation, however, of the very extraordinary catches of prime fish by the trawlers from 1860 to 1867 requires consideration, since it is not so obvious as that of the abundance of plaice. It is known that an extension of the trawling grounds on the Dogger Bank took place in 1860 and 1861, according to Mr. Alward's chart* of the fishing grounds; and also that the new grounds, when first exploited, were found to be very rich, especially in plaice and haddock (Sea Fisheries Commission, 1865, §§ 4,777–81, 6,908–10, 7,562, 7,672–8, 11,117-24).

The abundance of the two latter species appears to have been maintained down to the year 1876, since the offal catches of Mr. Knott's trawlers may safely be taken to have consisted principally of these fishes, and the corresponding items in Mr. Alward's returns did not fall below the same high average until the year 1877. This is a long period (seventeen years), and although there is a gap of seven years—from 1868 to 1874—in the returns, the evidence undoubtedly points to the conclusion that the large catches of plaice and haddock were not exceptional phenomena limited to one or two isolated years, but were indicative of the general abundance of these fish on relatively virgin grounds.

Nevertheless it is far from improbable that the abundance of fish fluctuated at that, as in more recent times, under the influence of climatic causes; and there is some evidence that the difference between the minimum and maximum catches within the period 1860–7, should be in part attributed to causes of this nature. The evidence tendered to the Sea Fishery Commissioners in 1863 by Grimsby, Yarmouth, and other fishermen tends to show that a general improvement of the fisheries took place in that year, which was not altogether to be accounted for by the exploitation of new grounds. Thus a Grimsby line fisherman stated in November, 1863, that the catches of liners had considerably increased that season, which was the best in his long experience (§§ 15,942–3); and similar statements were also made concerning soles and turbot (§§ 7,555–8, 16,085). Accordingly the increased catches of Grimsby trawlers in 1863 and 1864, both of prime and offal fish, should probably be treated as exceptional features due to the occurrence about this time of exceptionally favourable physical conditions, just as there is good reason to believe (see below, p. 55) that the weather in 1893 also caused an increased abundance of the same kinds of fish (prime, plaice, and haddock). I have not access at present to the detailed temperature returns prior to 1866, and must leave the verification of this suggestion to a later stage; but the years 1863 and 1864 occur in lists of exceptionally hot and dry summers (the spring also was hot in 1863), so that there is some preliminary evidence in support of this view. (Ramsay's *Bibliography, Guide and Index to Climate*, 1884, p. 348.) It is unfortunate that Mr. Alward's returns do not cover the period from 1868 to 1871, since the temperature conditions which prevailed in 1868 were remarkably similar to those of 1893, both in regard to the mildness of the first (winter) quarter, and the exceptional warmth of the spring and summer.

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* Deposited with the Fishmongers' Company; printed in Captain Dannevig's recent pamphlet, *Fiskeri og Videnskab*, Arendal, 1899.

The possibility of this interpretation should, in any case, be borne in mind, especially as it would, if confirmed, render intelligible the extraordinary drop in the average catches of prime fish after the year 1864, as shown by the returns of these Grimsby trawlers. The fall from 458 cwts., in 1864, to 137 cwts., in 1867, is far too rapid to be attributable to the effects of over-fishing under the conditions which then prevailed, but a fall to the same level from 259 cwts., in 1862, would be less incredible as a consequence of such a cause. From the difference in the distribution of plaice and soles it is not improbable that the effects of over-fishing would be earlier shown by the latter species than by the former.

On the other hand, it is exceedingly improbable that the difference between the abundance of prime fish at the beginning of this period (1860–2) and the scarcity at the end of the period (1888–92), as indicated by the average catches, is attributable to weather conditions, since this would involve the assumption that a type of weather prevailed in the former period capable of multiplying fourfold the normal abundance of these fishes. I do not dispute the possibility of such an increase, but it is so improbable that it would require a very elaborate investigation to establish it as a reasonable hypothesis.

The returns of both series of Grimsby smacks seem, therefore, to provide unequivocal evidence of a great depletion of the North Sea trawling grounds. Between 1860 and 1892 the average annual catch of prime fish dwindled from at least 300 cwts. to less than 60 cwts. per vessel; the catch of plaice and haddock from about 1,300 cwts. to 700 cwts.; and the total catch (in spite of increased attention to the less valuable kinds of fish) from *at least* 1,300 cwts. to *at most* 900 cwts.

From Mr. Alward's returns, which distinguish plaice from other offal fish, it is clear that the fall in plaice over the whole term of years must have been nearly as great as the fall in prime fish, since the catches at the end of the period averaged not more than about 200 cwts. per vessel, whereas they were nearly 1,000 cwts. in 1867, and were obviously not less than 600 or 700 cwts. in any of the years from 1860 to 1864, unless the high averages of offal in Mr. Knott's returns are to be attributed exclusively to the exceptional abundance of haddock.

These conclusions show that the depletion which has actually occurred in the North Sea is principally due to an enormous reduction in the abundance of flat-fish, both prime and plaice, the catches under each head about 1890 being less than one-fifth and one-third respectively of the quantities taken from twenty-five to thirty years previously. The catches of haddock have also diminished, but to a less extent, viz. from an average of over 800 cwts. per vessel to less than 500 cwts.

II. Official Statistics of the Grimsby Fisheries, 1886–99.

The smack-owners' returns, from which the foregoing conclusions have been drawn, bear internal evidences of their substantial accuracy, but to make assurance doubly sure upon this important point I subjoin a statement as to the condition of the Grimsby fisheries since 1885, based upon returns which have been kindly placed at my disposal by the Great Central Railway Company, and upon the Grimsby Registers of Fishing Vessels published in the Annual Statements of Navigation and Shipping.

TABLE VI., *illustrating the state of the Grimsby Fisheries (of all kinds) from* 1886 *to* 1899, *and showing for each year the Number of first class Fishing Vessels on the Register, the Total Weight of Fish sent inland by Rail, and the Average Weight (tons) of Fish per Unit of Fishing Power, each Steamer being regarded as equivalent to four Smacks.*

	Fishing Vessels (First Class).				Fish sent inland by Rail (tons).	
Year.	Total Registered.	Smacks.	Steamers.	Fishing Units (4:1).	Total.	Average per Unit.
1886	823	803	20	883	69,609	79
1887	839	818	21	902	66,698	74
1888	811	785	26	889	68,883	77
1889	789	752	37	900	66,280	74
1890	777	727	50	927	67,974	73
1891	811	713	98	1105	69,593	63
1892	793	683	110	1123	74,117	66
1893	787	649	138	1201	75,527	63
1894	771	604	167	1272	83,001	65
1895	720	532	188	1284	85,430	66
1896	630	400	230	1320	92,638	70
1897	630	350	280	1470	89,006	60
1898	611	247	364	1703	94,643	55
1899	524	99	425	1799	103,783	58

The figures representing the weight of fish sent inland by rail from the port of Grimsby have been provided by the General Manager of the Great Central Railway Company. They are exclusive of exported fish, and correspond with the figures annually published by the Board of Trade in their *Statistical Tables and Memorandum*, except for the years 1886–90 inclusive, for which years the Board of Trade's figures yield slightly lower "averages per unit" than mine, viz. 77, 73, 76, 72, and 72 respectively. The difference is insignificant, since both series of figures show practically the same progressive reduction in the annual averages.

The Railway Company's returns, however, exaggerate the true product of the Grimsby fisheries in two respects. They include a considerable quantity of herrings and mackerel landed at the port by Lowestoft, Scottish, and other vessels from the drift-net fisheries which are not pursued by Grimsby boats; and they also include the weight of boxes and ice, etc., in which the fish are packed for transport—items which it is well known are by no means inconsiderable.* From calculations which I have made, I estimate that about two-fifths of the total weight sent inland by rail should be deducted in order to cover these two sources of exaggeration. The inclusion of these extraneous items does not, however, affect the validity of the returns for my present purpose, which is merely to determine whether the official returns exhibit a constant or a declining catch per fishing boat per annum.

In order to establish this point I have taken each fishing steamer registered at the port to be equivalent in catching power to four sailing vessels; and in order to avoid any suspicion of having exaggerated the catching power in the later years of the period, I have purposely neglected all advances in the efficiency of the steamers due to increased tonnage or the adoption of new gear, such as otter trawls (cf. pp. 46–52).

In spite of these omissions, it is seen in the table that the averages per fishing unit have steadily diminished from 1886 to the present time. Owing to the increase of steam vessels and the decline of sailing vessels during the period, the amount of this diminution would be shown to have been very much greater if account had been taken of the relative increase in the catching power of steamers during the period. The results provide a conclusive confirmation of the general accuracy of the conclusions drawn from the smack-owners' returns in the preceding section of my paper.

A table of a somewhat similar character to the above, for the years 1878 to 1892, was submitted by Mr. Alward to the Select Committee in 1893, and is printed in their report (p. 9, § 216). The general character of our respective figures is the same, but Mr. Alward's figures yield rather higher averages than mine when worked out in the same way, the averages from 1886 to 1892 being 86, 84, 89, 75, 70, 65, and 66 respectively. From information received from the Railway Company, however, it would appear that Mr. Alward's figures representing the tonnage of the Grimsby fish traffic have not in all cases been subjected to the full deductions of fish exported to the Continent.

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* The fish occasionally landed by foreign trawlers also tend to swell the returns (cf. Holt, this Journal, iii. p. 411).

The quantity of fish exported to the Continent from Grimsby was uniformly about 4,000 tons annually from 1886 to 1892, after which year it regularly increased, being 5,000 tons in 1894, 8,000 tons in 1896, and over 10,000 tons in 1899. Nevertheless, even if this class of fish should also be attributed to the Grimsby fisheries, the fall in the average catch is equally apparent, being 83 tons for 1886, 70 tons for 1892, and 65 tons for 1899.

Moreover, the fall in the average catches cannot be attributed to any marked diversion to London during the later years of fish from Grimsby vessels which landed their catches at the home port in the earlier years of the period; for the proportion of sea-borne to rail-borne fish in the London markets has decreased appreciably since 1888, whether the calculation be based on the returns of the Fishmongers' Company (37 per cent. to 32 per cent.) or on those of the Board of Trade (33 per cent. to 29 per cent.). (Cf. *Statistical Tables and Memorandum for 1891*, p. 7: "The inference would be that there is a tendency to bring fish to London from distant parts by rail, instead of bringing them direct from the fishing grounds by sea. It seems highly probable that this is not merely a temporary change, but is one of a permanent character.")

III. The Lowestoft Trawl Fishery, 1883–98.

By the kindness of the Great Eastern Railway Company I am able to bring up to a more recent date the statistics of the Lowestoft trawl fishery which were submitted to the Select Committee in 1893 by Mr. Hame (*Minutes*, pp. 67–75). As stated by Mr. Hame in his evidence before the Committee, the Railway Company owns the fish docks, and receives a small toll for every package of fish landed. Consequently the returns of fish landed at the docks, as supplied by the Railway Company, possess an unusual degree of accuracy. A record is also kept by the Company of the number of trawling vessels which land their fish at Lowestoft; and although there is an inaccuracy here caused by the want of discrimination between vessels which regularly land their fish at Lowestoft and those (mostly hailing from Ramsgate and French ports) which only do so from time to time, it nevertheless seems possible to obtain a rough idea of the progress of the fishery by comparing the totals of fish landed by the trawlers with the gross number of trawling vessels from year to year.

The trawled fish landed at the port are classified by the Railway Company under Cod, Prime, and Offal. The returns of cod are given in "scores," those of prime and offal in "packages." Mr. Hame, in his evidence, treated the average weight of each package as about one hundredweight, and I am informed by the Dock Superintendent that this estimate is approximately correct; but there is no need to enter into this question for my present purpose, as the number of packages affords a sufficient index for comparing the condition of the fishery in successive years.

In the following table the returns of fish landed and of the fishing vessels prior to 1893 are copied from Mr. Hame's figures as published in the Minutes of the Select Committee. Those from 1893 onwards have been supplied to me directly by the Railway Company.

On recalculating the averages per vessel for the first period my results in three cases do not quite coincide with Mr. Hame's, probably as a result of printer's errors. For 1892 the error in Mr. Hame's table is undoubtedly in the averages, since the accuracy of the figures representing the total returns of fish landed in that year has been confirmed for me by the Railway Company. Consequently I have provided a new series of averages, marking with an asterisk those figures which differ by more than two units from the figures published by the Select Committee, which are placed in brackets alongside. The smaller quantities of cod-fish have not been averaged, for obvious reasons.

TABLE VII., *showing the Condition of the Lowestoft Trawl Fishery from 1883 to 1898 (from Returns provided by the Great Eastern Railway Company.)*

		Total Packages Landed.			Average No. per Vessel.	
Year.	Vessels.	Cod (scores).	Prime.	Offal.	Prime.	Offal.
1883	157	227	18,056	59,393	*115 (128)	378
1884	167	2,010 (*sic!*)	18,613	59,640	111	357
1885	173	225	24,228	77,948	140	450
1886	168	372	28,208	90,482	*168 (160)	539
1887	190	101	24,341	87,710	128	462
1888	230	53	23,022	117,552	100	511
1889	235	169	24,844	128,156	106	545
1890	260	151	25,647	136,810	99	507
1891	265	32	34,701	189,770	131	716
1892	360	338	32,013	210,504	*89 (100)	*585 (684)
1893	394	258	37,523	219,830	95	558
1894	365	189	34,340	184,099	94	504
1895	369	57	31,088	187,564	84	508
1896	350	84	28,018	177,437	80	507
1897	326	13	28,455	168,678	87	517
1898	318	5	29,283	170,543	92	536

The averages per vessel indicate a distinct falling off in the quantities of prime fish landed by each vessel and a rise in the quantities of offal, though the fall in prime fish occurs throughout the period, while the rise in offal is limited to the earlier years. These features can best be seen by averaging the returns per vessel for longer (quinquennial) periods, a method which eliminates the minor fluctuations, thus:—

	Prime.	Offal.
1883–88	127	449
1889–93	104	582
1894–98	87	514

So far as the official figures go, therefore, the Lowestoft trawl fishery is declining as well as the fisheries further north. It should be remembered that the trawling grounds of the Lowestoft smacks are mostly in shallower water than those of the Hull and Grimsby vessels, and are bounded approximately by the parallels 51°·30 and 53°·30, being altogether south of the Dogger and south and west of Heligoland (Select Committee, 1893, §§ 1,538, 1,539, 1,634, 1,639; also first Report of the Inspectors of Sea Fisheries, p. 14).

On the other hand, the inclusion of temporary visitors in the list of vessels working from the port has the effect of depressing the estimated averages below the true values, and in particular years this source of error may attain exceptional dimensions, *e.g.* 1892 (cf. the actual average of an exclusively local fleet of that year, cited below, p. 45). Consequently the evidence afforded by these returns should be treated cautiously, and no undue importance should be attached to the averages deduced from them for isolated years.

IV. The Entire Bottom Fisheries of England and Wales during the decade 1889–98.

In this section I propose to compare the total quantities of "bottom fish" landed annually on the English coasts with the total number and catching power of the deep-sea trawlers and liners for each year of the decade, separating the fisheries prosecuted by the East Coast vessels in the North Sea from the fisheries carried on in the English and Bristol Channels and other Western waters.

1. Statistics of Bottom Fish.

The method adopted for determining the quantity of bottom fish annually landed is the same as that used by my predecessor, Mr. Cunningham, as described in his paper on "The Immature Fish Question" in this Journal (vol. iii. p. 54). The Board of Trade's returns in their annual *Statistical Tables and Memorandum* have been taken as the basis, the annual totals of mackerel, herrings, pilchards, and sprats being deducted from the totals of "all fish, except shellfish." The elimination of the drift-net fish yields a remainder which may safely be regarded as the product of the trawl and line fisheries together.

In distinguishing the products of the North Sea fishery, however, it has been necessary to deviate to some extent from the line of separation adopted by the Board of Trade (the North Foreland), whereby Ramsgate is excluded from the East Coast ports (Mr. Berrington's Evidence, Select Committee, 1893, § 2,426). The principal fishing grounds of the Ramsgate trawlers largely coincide with those of the Lowestoft vessels in the southern part of the North Sea, and I am informed by the Harbourmaster of Ramsgate through the Board of Trade, that "most of the Ramsgate trawlers work in and out of Lowestoft as much as they do here [*i.e.* Ramsgate]; it depends greatly upon the wind which port they can more easily make." Under these circumstances it was clearly necessary to transfer the figures for Ramsgate catches and vessels from the South to the East Coast. Accordingly, the line which I have adopted for separating the East from the South Coast lies between Ramsgate and Deal, thus coinciding with the classification of the fishing ports originally given by the Inspectors of Sea Fisheries in their first Annual Report, p. 25. It is, perhaps, worthy of consideration whether it would not be advisable to revert to this original scheme in any future rearrangement of the fishery statistics.

The Board of Trade has kindly provided me with a detailed return of the fish landed annually at Ramsgate since 1888, from which the following figures, representing the total quantities of "bottom fish" landed at the port, have been derived.

Year.	cwts.	Year.	cwts.
1889 . .	30,319	1894 . .	31,425
1890 . .	29,285	1895 . .	37,162
1891 . .	30,837	1896 . .	36,129
1892 . .	33,351	1897 . .	36,417
1893 . .	35,406	1898 . .	31,606

These figures have been deducted from the totals of bottom fish for the South Coast derived from the *Statistical Tables*, and added to the corresponding figures for the East Coast. The resultant figures,* prepared in the manner described and reduced to tons, are given for the various coasts in Table VIII. (p. 34).

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* The figures in Cunningham's table on p. 55 (*l.c.*) contain two errors of some importance. His total for drift-net fish in 1889 should be 2,428,118, instead of 1,428,118; and his total for bottom fish in the same year should be reduced by the same amount (one million). For 1890 his figures for the same two items should be 2,000,644 and 4,099,986 respectively. The latter errors clearly arose from an alteration in the order of the various items in the *Statistical Tables* for that year, the figures for plaice having been taken by Cunningham to represent herrings. These errors materially affect his conclusions at the top of p. 57, which need correction.

The only source of uncertainty (apart from the question as to the general reliability of the official returns) which I can discover in this method of determining the annual quantities of bottom fish landed arises from the unspecified nature of the item which appears in the *Statistical Tables* as "Fish not separately distinguished, except shell-fish." As this item, however, clearly includes such fish as whitings, gurnards, dabs, skates, and rays, and as all the important drift-net fish are separately distinguished, no appreciable error can be introduced by treating this item of sundries as forming part of the total of bottom fish. It forms one-fifth of the total catch in 1889, and one-seventh in 1898; but the proportion is considerably greater for the South and West Coasts than for the East Coast—a feature of which one would like to know the explanation.

2. Statistics of Fishing Boats.

By Clause 17 of an Order in Council of the 18th of June, 1869, which has reference to the Registration of British Sea Fishing Boats under Part II. of the Sea Fisheries Act of 1868, it is provided that the register of sea fishing boats shall contain, among other details, "the name of the vessel and of the port to which she belongs, description of her rig and of her ordinary mode of fishing, her registered number, class, tonnage, and length of keel, and number of crew usually employed."

In view of this provision I expected, in the course of the present investigation, to be able to obtain an authentic statement of the number of trawling vessels on the register for each of the past ten years; but, after correspondence with the Customs Establishment and the Board of Trade, it has been found necessary to depend upon indirect sources of information, in consequence of information received from the Board of Trade to the effect that "the Returns rendered by Collectors of Customs prior to 1893 no longer exist" (March, 1900). This circumstance is much to be regretted, for I am confident that for the purposes of fishery statistics the unpublished portions of the fishing-boat registers contain data which are sufficient to provide an authentic list of the numbers of deep-sea fishing boats engaged in trawling, even if they are of less value for determining the numbers of deep-sea line vessels and drifters. It is rare, however, for the same port to possess fleets of all three classes of vessel, so that even the numbers of first class liners and drifters could usually be obtained by deducting the number of registered trawlers from the total of all kinds registered at the respective ports.

Nevertheless, in spite of the absence of any official lists of the total

TABLE VIII., *showing the Total Weight of Bottom Fish landed (tons), the Total Catching Power of First Class Trawlers and Liners expressed in "Smack-units," and the Average Catch per Smack-unit for all Coasts of England and Wales and the Isle of Man, and for each Year from* 1889 *to* 1898 *(tons).*

Year.	East Coast.			South and West Coasts.*			Total of all Coasts.		
	Total Catch.	Smack-units.	Catch per Unit.	Total Catch.	Smack-units.	Catch per Unit.	Total Catch.	Smack-units.	Catch per Unit.
1889	173,180	2,859	60·6	28,642	946	30·3	201,822	3,675	54·9
1890	172,055	3,086	55·7	32,944	1,071	30·8	204,999	3,942	52·0
1891	180,054	3,711	48·5	28,772	1,067	27·0	208,826	4,558	45·8
1892	187,512	4,057	46·2	33,820	1,254	27·0	221,332	4,876	45·4
1893	200,281	4,307	46·5	33,737	1,157	29·1	234,019	5,133	45·6
1894	215,408	4,599	46·7	33,819	1,070	31·6	249,227	5,400	46·1
1895	228,180	4,918	46·4	36,626	1,243	29·5	264,805	5,781	45·8
1896	232,034	5,620	41·3	40,732	1,514	26·9	272,766	6,544	41·7
1897	225,864	6,099	37·0	45,775	1,788	25·6	271,640	7,363	36·9
1898	230,656	7,143	32·3	55,010	1,896	29·0	285,667	8,503	33·6

* See remarks on pp. 62 to 64.

number of boats engaged in each of the different kinds of fishery, it has been possible to prepare a list of first class vessels which is probably sufficiently accurate for my present purpose from the information published in the Annual Reports of the Inspectors of Sea Fisheries and in the Annual Statements of Navigation and Shipping, supplemented, where desirable, by correspondence with local authorities.

The Annual Reports of the Inspectors contain returns rendered by the collectors of fishery statistics at each port, giving the approximate number of boats of each class engaged in each fishery, whether belonging to the station or not. These returns commenced in 1889. In 1892 a column was added to the returns showing the total number of boats of each class belonging to each station, and, although there are slight differences between the figures in this column and those in the Fishing Boat Registers, the numbers assigned to the first class boats are practically the same.

It is not difficult from a perusal of these returns to form a fairly correct idea of the numbers of local boats engaged in the different modes of fishery. The irregular numbers and migrant habits of the drift fleets, and the periodic movements of such vessels as the Brixham and Ramsgate trawlers, undoubtedly affect the collectors' returns for various ports to a considerable extent, and preclude the possibility of using their figures, without further analysis, for statistical purposes, owing to the inclusion of large numbers of vessels in the returns for more than one port. But, so far as the first class vessels are concerned, it is always possible to trace the number of non-local boats by comparing the collector's total for each port with the register of fishing vessels, and in the great majority of cases it is possible also to discover the kind, or kinds, of fishery in which the visitors are engaged. In this way the number of local boats engaged in each fishery can be determined with a considerable degree of exactitude, thus permitting the addition of the numbers so obtained in order to form an approximate total of the boats engaged in any one form of fishery, either for the country as a whole, or for particular sections of the coast line.

The method pursued was in the first place to tabulate the collectors' annual returns of the vessels engaged in trawling for the entire term of years since 1889, and for all ports, distinguishing steam trawlers from smacks, first class from second and third class boats, and deep-sea from inshore trawling vessels. The table showed at a glance that the numbers of trawlers of the second and third class might be neglected entirely, partly on account of their small size (under fifteen tons), and partly from their relatively small numbers throughout the period. The inclusion of these boats, with their feeble catching power, would obviously not materially affect the results.

§ i. *Number of Trawling Smacks.*

Leaving the question of steam trawlers for later consideration, it appeared, upon detailed examination, that first class sailing trawlers are practically limited to the ports mentioned in Table E. The returns also assign a number of these boats to the fisheries from London (Shadwell), Hastings,* Eastbourne, Shoreham, Newlyn, Ilfracombe, Milford, Holyhead, and Bangor. But the figures for Shadwell in reality indicate the numbers of trawlers supplying the Shadwell carriers, the few boats at Eastbourne trawl for a very short portion of the year, and none of the remaining ports possess sailing trawlers of their own. The Hastings trawlers hail from Rye; the Shoreham boats partly from Lowestoft and partly from Brixham; the Newlyn, Ilfracombe, Milford, and, to some extent, Tenby boats from Brixham and Plymouth; the Holyhead, and, probably, Bangor boats from Douglas, Liverpool, Fleetwood, and Carnarvon.

As regards the determination of the actual numbers of trawlers owned at the various ports, no difficulty was experienced in regard to the ports of the South and West Coasts, since, with the exceptions just mentioned, the number of trawlers estimated by the collectors to be working from the various ports was found to correspond to all intents and purposes with the total of first class vessels, less steam fishing vessels, registered at the ports. The same remark applies to Ramsgate, which, so far as trawling is concerned, should be included among the East Coast ports, owing to the position of the fishing grounds usually frequented by the Ramsgate trawlers.

But there were considerable difficulties in determining exactly the number of trawlers at the remaining ports on the East Coast, principally due to the uncertainties as to the number of local vessels engaged in the drift fisheries from each port. It is, of course, well known that these fisheries are pursued by a nomad fleet composed of Lowestoft, Yarmouth, Scottish, Manx, and Cornish vessels; and as the collector's estimate of the number of vessels engaged in these fisheries from Yarmouth or Lowestoft does not discriminate between the local and the non-local boats, it was impossible to use the method of comparing the total of the collector's returns with the registered total in order to decide whether his estimates of the trawlers included any proportion of boats from other ports.

Fortunately, in the most difficult case (Lowestoft), it was possible to obtain reliable information as to the number of trawlers using the port for a long term of years from the Great Eastern Railway Company, the owners of the fish-docks (Table VII). Evidence from the same source, together with independent evidence as to the numbers of the local trawlers, was furnished to the Select Committee on Sea Fisheries in 1893 by Mr. Hame, who places the local trawlers for 1892 at about 300, and for 1893 at 325 (Minutes of Evidence, §§ 1,532 and 1,642). The latter number practically coincides with the collector's return for the same year in the Report of the Inspectors, whereas the gross number of trawlers using the port is given by the Railway Company as 394 for 1893, and for each year from 1889 to 1896 uniformly exceeds the collector's figure, the excess usually amounting to from 30 to 70. The dock superintendent informs me that the number of Ramsgate trawlers landing their fish in Lowestoft may be placed at about 50 or 60.

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* The trawlers for Hastings in 1891 are returned as follows: "Steam, 20; second class, 50." As the collector remarks that "the twenty first class *smacks* are from Rye," and as neither Rye nor Hastings ever possessed more than three steam trawlers, it is obvious that the figures should be "Steam, 2; first class, 20; second class, 50," the numbers approximating to the returns for Rye as in other years.

From all this evidence it is clear that the collector's returns of the trawlers engaged in the Lowestoft fishery are not the gross returns of trawlers using the port, but more nearly represent the numbers of local trawlers. On the other hand, the collector's returns for the four years 1890 to 1893 (viz. 203, 186, 350, 320) fluctuate in a manner which is inconsistent with the view that they represent the local trawlers exactly, and as the Railway Company's gross (but exact) returns show a continuous increase from 1886 to 1896, I have "smoothed" the collector's figures for 1891 and 1892 in conformity with this fact. The correction may not be perfectly exact, but it probably reduces the error to insignificant dimensions. Mr. Alfred Turner, of Lowestoft, informs me that the local boats have increased since 1893, but rather than exaggerate the catching power in these later years, I have preferred to retain the collector's estimate, in the absence of definite information.

In the case of Grimsby an exact classification of the fishing boats registered in 1899 is given by the Great Central Railway Company in an official pamphlet* dealing with that port, the whole of the vessels being included as trawlers or liners, without mention of drift boats. As the number of trawlers and liners in the collector's returns for Grimsby in any year does not exceed the total registered, it may be safely assumed that at this port also the collector's returns of these classes of boat approximately represent the numbers of local boats in active work. It is possible that a number of Grimsby trawlers, which supply the Shadwell market by means of steam carriers, should be added to these figures, but in the absence of conclusive information I have preferred to omit them.

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* *Leading Events and Statistics in connection with the Formation and Development of the Port of Great Grimsby.* Manchester, 1900. "Steam line vessels, 52; sailing line vessels, 29; steam trawlers, 373; sailing trawlers, 70; total (registered), 524." In a previous edition, dated 1894, the Grimsby fishing boats for 1893 are classified as, "Trawlers, 670; cod vessels, 127; total, 797." These figures show that my figures for the whole period are sufficiently near the mark.

The collector's returns for Yarmouth have been accepted without change. The same is true for Hull, except that the collector's number for 1892 has been reduced from 300 to 280, since the Register, as well as other evidence, precludes the possibility of admitting any increase in the number of Hull smacks during the decade.

In the case of Scarborough Mr. Ashford, the Fishery Officer of the North-Eastern Committee, informs me that the local smacks have now (February, 1900) entirely given up trawling. "There are a few (7) which have been altered in rig, and are at present engaged in line fishing. These, with twenty yawls, also liners, belong to the port. There are about twenty yawls laid up, which have not left the harbour for years, it being considered not worth while to keep them fit for sea. We have also belonging to Scarborough fifteen paddle trawlers and three screw trawlers, and one screw trawler working from Scarborough but owned at Hull." Mr. Cunningham reported only eighteen sailing trawlers and nine or ten steamers as belonging to Scarborough in 1895 (*Jour. M. B. A.*, iv. p. 113). The collector's returns of the sailing trawlers working from the port are adopted in my table up to 1893, but his subsequent returns (40, 40, 19, 28, 8) so clearly include a variable non-local element that, in view of the evidence cited above, I have reduced the excessive figures for three of these years, so that the entire array of figures for the ten years exhibits a continuous decrease within verifiable limits.

The results of my analysis, as set forth in Table E, p. 67, show that the estimated number of first class trawling smacks belonging to the East Coast has fallen considerably during the decade, from 1,737 in 1889 to 1,015 in 1898. The fall is not, however, quite regular. The Scarborough, Hull, and Grimsby smacks show a general decrease, but the Yarmouth fleet (though subsequently broken up) was greatly increased in 1890 and the Lowestoft fleet about 1892 (cf. the collector's returns for 1892 and 1893 and the Great Eastern Railway Company's returns, Table VII.), while the Ramsgate vessels, as shown by the collector's returns and the Fishing-boat Register, have also steadily, though slightly, increased in numbers.

On the South and West Coasts the total number of smacks has remained practically constant throughout the decade, varying from 546 at the beginning to 525 at the end. Here, also, the same phenomenon is exhibited as on the East Coast, viz. a decrease at certain centres (Liverpool, Fleetwood) where the smacks are being replaced by steamers, and an increase, though slight, at others (Rye, Brixham) where steam trawlers show no signs of increase.

§ ii. *The Number of Steam Trawlers.*

The number of steam trawlers has been determined upon a different plan from that followed in the case of the smacks, owing to the circumstance that they form the great majority of the steam fishing boats in general. Consequently the Register has provided the basis for my estimates, and the collectors' returns have been used merely for determining the number of deductions which should be made to cover the number of steam liners, carriers, and drifters. According to the Reports of the Scottish Fishery Board a certain number of English steam trawlers land their fish regularly at Scottish ports. These, therefore, have been also deducted. The total deductions made for the different years of the decade (Table H, p. 69) are as follows:—

	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
Steam liners . . .	40	50	50	60	70	80	90	100	100	80
,, drifters . . .	—	—	—	—	—	—	5	15	20	35
,, carriers . . .	33	32	34	37	41	39	45	45	50	50
,, trawlers, in Scotland	30	31	37	(38)	39	38	35	32	31	37
Total deductions .	103	113	121	135	150	157	175	192	201	202

The figures representing the liners in the above table are discussed below. The numbers of steamers engaged in the drift fisheries are estimated from the figures returned by the collectors of statistics for Grimsby and Yarmouth. They are undoubtedly excessive, since Grimsby possesses no drift boats at all, and it seems probable that the majority of the steamers engaged were only temporarily occupied as carriers during the summer season: but as the deductions to be made under this head are limited to the later years of the decade, I have purposely taken the highest estimates possible in order to avoid the possibility of exaggerating the catching power in these years. The "carriers" of mackerel mentioned in the collectors' returns under Neyland are not registered as fishing vessels. The Harbourmaster informs me that these vessels are merely chartered for the season, and are employed in the coasting trade or in towing at other times. Consequently no deductions have been made for them.

The principal uncertainty in the series of deductions concerns the numbers which should be written off to cover the carriers for the trawling fleets. The collectors of statistics only enumerate such vessels for the ports of Yarmouth, Shadwell, and Billingsgate, and my figures represent the totals for those stations. They no doubt include the majority of the carriers, so that the error introduced under this head is probably insignificant. Indeed, the steam carrier, although merely engaged in transporting fish caught by other boats, is undoubtedly an element in the catching power as a time-saving contrivance; and the deficiencies in my estimates of these vessels may serve, by their inclusion among the trawlers proper, as a rough measure of the catching power due to the carriers in general.

The figures representing East Coast trawlers which regularly land their fish at Scottish ports have been taken from the Annual Reports and other official publications of the Scottish Fishery Board, except for the year 1892, the figure for which has been interpolated, owing to my failure to find an official record for that year.

The total deductions enumerated in the table have been made both for the entire coast of England and Wales and for the East Coast, but not for the Western Coasts, since they are based on data which apply to the East Coast only. The steamers registered for the South and West Coasts have been taken as being trawlers without exception.

§ iii. *East Coast Trawlers in Western Waters.*

As already remarked, for the purpose of these statistics of Bottom Fish and Fishing Vessels, Ramsgate has been included among the East Coast ports and as the southern boundary of the East Coast district. But in determining the number of boats engaged off the East Coast and off the remaining coasts respectively, it seemed necessary to take account of the East Coast trawlers (both steamers and smacks) which have more or less regularly visited the South and West Coasts during recent years. The methods adopted in order to estimate the numbers of these "East Coast visitors" of each kind were as follows.

In the case of steamers the collectors' estimates of the number of steam trawlers working from the ports of Plymouth, Newlyn, Milford, and Fleetwood were added together for each year, and the numbers of steam fishing boats actually registered at these ports were deducted from the total so obtained. The differences have been taken to represent the visitors from the East Coast. Thus:—

Steamers reported to be Working.

	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
Plymouth	2	—	—	—	—	—	13	27	30	35
Newlyn	6	8	8	4	3	3	1	1	2	2
Milford	20	35	36	67	60	47	45	55	60	60
Fleetwood	—	—	—	11	11	10	21	19	36	40
Total . . .	28	43	44	82	74	60	80	102	128	137

Steamers registered.

	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
Plymouth . . .	—	—	—	—	—	—	—	—	—	2
Milford . . .	2	2	4	12	12	12	12	24	24	30
Fleetwood . . .	—	—	—	—	—	—	6	8	36	38
Total . .	2	2	4	12	12	12	18	32	60	70
Difference.										
East Coast visitors . .	26	41	40	70	62	48	62	70	68	67

It is probable that by this method the number of visitors has been exaggerated, as a certain number of the steamers were no doubt included by the collectors in their returns for more than one port. Moreover, the East Coast steamers do not invariably spend more than a portion of the year in the Western waters, so that for strict accuracy a suitable deduction should be made under this head. In the absence at present of satisfactory information on those points, however, I have provisionally retained the gross numbers given above as the basis of my calculations, reserving to the sequel the consideration of the extent of the error thereby introduced.

The allowance thus made to cover the North Sea immigrants has only been added to the numbers of registered steamers on the South and West Coasts. Strictly speaking, a corresponding deduction should be made from the registered total for the East Coast steamers, but this has not been done. The difference in treatment is due to the fact that, whatever the exact number of these East Coast immigrants in successive years, they clearly formed a large percentage of the total number of steamers fishing off the Western Coasts (see Table H, p. 69), whereas their deduction from the totals for the East Coast would make no difference in the general result beyond causing a slight and practically uniform increase in the average catches throughout the period.

The numbers of the East Coast sailing trawlers working from the ports mentioned above and from Holyhead have been determined after careful study of the information given in the Annual Reports of the Inspectors of Sea Fisheries and the collectors' returns, and after correspondence with the harbourmasters of Milford and Holyhead. "When these [the Milford] Docks were first opened (in 1889) a large number of Hull vessels, both steam and sail, landed their fish here in addition to many Brixham smacks. The Hull smacks, proving somewhat large and expensive for the short voyages made on this coast, were gradually withdrawn, but most of the steamers continued fishing here until the end of 1893. The nucleus of a local fleet of steamers formed in the interval, and this fleet has gradually been increased to its present size. The steamers here at present are all owned by firms whose headquarters are here, and very few of them fished out of other ports previous to their arrival here" (J. C. Ward, Manager of the Milford Docks Company, February, 1900). In 1899, during the principal season (February 1st to June 30th), the fleet of smacks working from Milford consisted of 206 vessels, composed as follows: Brixham vessels, 142; Lowestoft, 25; Ramsgate, 12; various, 27.

As regards Holyhead, the trawlers landing fish at the present time appear to hail principally from Douglas and Liverpool, a small number, however, belonging to Fleetwood, Carnarvon, and Grimsby. During the year from March, 1899, to February, 1900, fourteen trawlers, on twenty-three voyages, were boarded by the boats of the Queen's Harbourmaster. Two only were East Coast (Grimsby) vessels, five hailing from Douglas, five from Liverpool, and one each from Fleetwood and Carnarvon. These figures, however, merely serve to convey an idea of the proportion of boats from various ports, as the majority of fishing-vessels are never boarded by the Harbourmaster's officers. The Grimsby vessels were each boarded on one occasion only; the Douglas, Liverpool, and Fleetwood boats usually twice. This tends to show that the Grimsby vessels were not using the port so frequently as the Lancashire and Manx trawlers, and were possibly there for only a portion of the year. Their "voyages" both occurred in February, 1900.

For Plymouth the number of East Coast trawlers fishing from the port in 1898 is stated by the collector of fishery statistics (Report of Inspectors, p. 165) to have been sixteen, *i.e.* twelve from Lowestoft and four from Ramsgate. These boats, however, do not use the port for more than a short period in the spring (February and March), so that it is probable that a majority of the same boats reappear later on at Milford, and are included in the estimates for that port. I have therefore taken the number of Lowestoft and Ramsgate trawlers known to have frequented the harbour of Milford in 1899 as representing approximately the total number of East Coast smacks fishing in the Western waters generally during the preceding year. The figures for the previous years are rough estimates, culminating in this number and determined in correspondence with the principal features known to have characterised these immigrations of East Coast trawlers, viz. the original invasion of Hull trawlers in 1889 and 1890, the subsequent falling off, and the ultimate increase of the smaller class of vessel from Lowestoft and Ramsgate (Table E). In selecting the figures, I have been also influenced to some extent by the fluctuations in the numbers of vessels estimated by the collector of fishery statistics at Milford, the general features of which have been corroborated by the harbourmaster at that port.* Owing, however, to the fact that these vessels usually return to their own ports for the winter season, it is probable that the figures exaggerate the additional catching power due to the East Coast immigrations, although they probably convey a correct idea of the relative number of the immigrants in successive years. This point, as in the case of the steamers, will be reconsidered in the sequel.

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* I am informed by the Harbourmaster of Ramsgate that about twenty Ramsgate trawlers were fishing in the Bristol Channel during the spring of 1900, and were already returning home in the middle of May. A certain number, however, always work off the Sussex Coast in the summer, landing their fish daily at Brighton or Hastings.

§ iv. *Number of Liners.*

In determining the number of first class vessels engaged in line fishing, it seemed preferable, after examination of the figures given by the collectors of fishery statistics for successive years, to restrict the computation to the East Coast ports, since the number of boats principally engaged in this mode of fishing from the ports of the South and West Coasts is exceedingly small and uncertain. In the case of steam liners, the ports of North Shields, Hull, and Grimsby have been alone selected, since the figures assigned by the collectors to such ports as Sunderland, Hartlepool, and Whitby are both insignificant and variable. In the case of sailing liners, the ports selected were Staithes, Scarborough, Filey, Bridlington, Grimsby, and Harwich. The figures assigned to each of these ports in each year in Table F are those given by the collectors of statistics, subject to deductions, where necessary, of vessels clearly belonging to other ports.

The totals, as set forth in Table F, show that while the steam liners have doubled during the decade, the sailing liners of the first class have fallen from about 240 to 80.

3. Relative Catching Power of Trawlers and Liners.

However accurate the returns of the quantity of fish landed may be, and however exact the estimation of the numbers of vessels engaged in the different kinds of fishery, it is impossible to obtain a satisfactory view of the condition of the fisheries in general without also taking into consideration the relative catching power of the different classes of fishing vessels and the changes wrought in their efficiency at different times by the introduction of new fishing appliances, and by increased speed and storage capacity. The gross returns of fish landed from year to year are meaningless for purposes of accurate comparison unless they are taken in relation with the total catching power of the fishing vessels for the same periods, and it is impossible to form even an approximate idea of the growth of catching power from the mere numbers and registered tonnage of the vessels as a whole. It is indispensable that the vessels should be sorted out according to their mode of fishery and their means of propulsion, and their respective catching powers reduced to some uniform standard of efficiency.

§ i. *The Trawling Smack as a Unit of Catching Power.*

I have therefore adopted the deep-sea sailing trawler as a standard unit of catching power, and have sought to express the average catching powers of other vessels in terms of this "smack-unit." It will be seen from Tables A–D, which give the actual annual catches of four Grimsby sailing trawlers for a long term of years, that, however variable the catches are from year to year, there is an appreciable uniformity (with few exceptions) in the individual catches for the same year; and, although the sizes of deep-sea sailing trawlers vary to some extent at different ports, it appears to be admitted that these differences are mainly adaptations to the local conditions of the fishery, and do not seriously affect the gross catches made by the respective types of vessel on the grounds to which they are suited and on which they usually work.

On the other hand, the gross catches of individual trawlers are undoubtedly affected by the "fleeting" system. The large increase in 1882 in the catches of the Grimsby trawlers (compare Table IV.) is principally due, as Mr. Alward informs me, to a general extension of the fleeting period which took place at Grimsby in that year—from an average of about five or six months in previous years to eight months in 1882. The system could not, however, be maintained owing to the opposition it aroused, which culminated in a general strike of the hands in 1883. The subsequent restriction of the fleeting period in 1884 to its former limits was followed, as may be seen in Table IV., by a reduction of the annual catches to their former proportions. The illustration suffices to give an idea of the increased catches which may directly ensue from the adoption of means of propulsion, or methods of work, which save the time spent in voyaging to and from the more distant fishing grounds. Nevertheless it must be borne in mind that the distances to be traversed by the Humber smacks are necessarily greater than those usually covered by the "single boaters" of more southern and of western ports, whose fishing grounds, though more limited, are situated in closer proximity to the ports of landing. Consequently there is no ground for believing that the annual catches of the Ramsgate and Brixham trawlers are very much less than they would be if these vessels were to adopt the fleeting system as carried out at Grimsby and Yarmouth. So far as the Lowestoft trawlers are concerned—and they fish to a large extent on the same grounds and under the same conditions as the Ramsgate vessels, and do not fleet for more than a couple of months in the year—this conclusion can be verified; for in his evidence submitted to the Select Committee in 1893, Mr. Hame stated that the average catch for 1892 yielded by thirty-eight vessels worked by one firm at Lowestoft amounted to 139 cwts. of prime fish and 710 cwts. of offal (Minutes of Evidence, §§ 1,540, 1,626). It will be seen by comparison with Table IV. that the total catch (849 cwts.) even exceeded the average catch of Mr. Alward's four smacks for the same year, though practically identical if we take the previous year's average also into consideration. The data, however, upon which I principally depend for my estimate of the catching power of the sailing-trawler unit consist of Mr. Alward's returns of the actual catches of four of his Grimsby trawlers, already discussed (see Tables A–D and IV.).

§ ii. *Relative Efficiency of Steam Beam Trawlers.*

The catching power of steam beam trawlers compared with smacks has been variously placed at from three to six fold (Select Committee, 1893, Minutes, §§ 351, 1,165, 4,119). Mr. Alward, in 1893, estimated it at between four and five times the efficiency of the sailer, and I am able to submit actual figures in substantiation of this opinion. Mr. Alward has kindly lent me extracts from his books, which show the actual annual catches of one of his steam trawlers for each of the years 1883, 1884, and 1885, and the catch of another steamer for 1885.

TABLE IX., *comparing the Average Annual Catches of Steam and Sailing Beam Trawlers, Grimsby,* 1883-85, *and showing the Relative Efficiency of the Steamer at that date.*

	Boats.	Period.	Average Annual Catch (cwts.).				
			Plaice.	Haddock.	Prime.*	Rough.†	Total.
A	1 steamer	3 years, '83–'85.	818	2325	125	668	3936
	4 smacks	do.	315	556	94	81	1043
B	2 steamers	1885 . .	717	2352	120	654	3844
	4 smacks	do. . .	280	477	90	89	961
	Relative Efficiency of Steamer.	A	2·60	4·18	1·33	8·25	3·77
		B	2·56	4·93	1·33	7·35	4·00

In Table IX. I have averaged these figures in two ways, and it will be seen that, as in the case of the sailing trawlers, the average quantity landed by the steamers in adjacent years is remarkably uniform. Side by side with these averages I have placed in the same table the average catches of the four sailing trawlers for the same term of years, and it can thus be seen that during the period 1883–5 the steam trawler caught close upon four times as much fish in a year as the sailing trawler. The relative efficiency of the steamer is seen to vary as regards the different items brought up in the trawl—a variation which is apparently determined, to a large extent, by the natural distribution of fish in the North Sea. Thus the steamer caught two and a half times as much plaice as the smack, from four to five times as much haddock, about the same quantity of prime fish, and from seven to eight times as much rough fish. Leaving out the latter item, the steamer's great efficiency as regards haddock would appear to be due to the greater abundance of this fish in the more distant grounds to the northward; its moderate efficiency as regards plaice to the more uniform distribution of this fish over the whole basin of the North Sea; and its small efficiency as regards turbot, sole, and brill to the southern and shallow water proclivities of these latter types of fish. That is to say, the steamer's efficiency increases in proportion to the distance from the port of landing of the grounds on which the different species live in greatest abundance.

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* "Prime" includes Turbot, Sole, and Brill. In these figures, however, Lemon Soles also are probably included in the case of the steamers, but excluded in the case of the smacks. Consequently the figures representing the relative efficiency of the steamer in catching prime fish are probably excessive. The steamer's average annual catch of "soles" in 1883-5 was 62 cwts. If we assume one-third of the catch to have consisted of lemon soles, the efficiency of the steamer for prime fish is reduced to 1·11.

† "Rough" includes Cod, Gurnet, Dabs, Catfish, Skates, and Rays (Roker), etc. In the case of the smacks it also probably includes Lemon Soles, so that the index of the steamer's relative efficiency in catching "rough fish" is probably rather below the true value. The figures for "prime" and "rough" fish are invalidated by Mr. Alward's uncertainty at this date as to his treatment of lemon soles in the case of the steamers.

But it is well known that since 1885 the relative catching powers of steam and sailing trawlers have diverged to a still greater extent, for, whereas the rig and fishing gear of the smacks have remained practically stationary, the steamers have been subject to continuous improvements as regards speed, storage capacity, tonnage, and size of trawl. The improvements under the latter head culminated in 1895 in the adaptation and general use of the otter trawl in place of the beam trawl. Consequently if the relative efficiency of steamers to smacks was fourfold in 1885 it must have become distinctly greater than that by 1893, and has undoubtedly increased since then. The increased efficiency due to the adoption of the otter trawl can be determined with precision (see Tables XI., XII.), and exceeds 30 per cent. on the gross catches, but the data on which I depend for measuring the improvement due to other causes are necessarily somewhat indirect. To directly compare the average catches of steamers in 1885 with the catches in 1894, and to conclude that the difference is a measure of the changes wrought in efficiency during the interim, would be to beg the question at issue, and to assume that the abundance of fish on the grounds has not changed. In view of the evidence afforded by the catches of Mr. Knott's and Mr. Alward's smacks, this position cannot be assumed as a basis for calculations. The question could be decided most conclusively by comparing the catches of Grimsby steamers in 1893 and 1894 with the average catches of the smacks in the same years; for, assuming that the efficiency of the smacks has remained the same, any difference in the relative efficiency of the steamers since 1885 would be attributable to improvements in the type of vessel and fishing gear. Unfortunately exact returns of individual catches for these later years are not yet available either for steamers or smacks, though Mr. Alward tells me that he has long intended, and still hopes, at some future time to bring his figures up to date both for sailing and steam fishing vessels. I have tried in various other directions to obtain such information from smack-owners, but hitherto without success.

Nevertheless Mr. Alward's opinion is entitled to consideration. When sending me his returns already quoted, he wrote: "The figures for the two steam trawlers which I am submitting will convey a very poor idea of the quantity of fish caught in the interval between 1885 and the present time. They will serve only as a comparison of the early class of steam trawlers and the sailing trawlers of that day. In the interval between 1885 and the present time several new fishing grounds have been worked, and the modern steam trawler would catch about *double the quantity* caught by either of the two steam trawlers whose figures I give, *if they had been fishing on the same ground at the same time.*"

In a further communication Mr. Alward writes, "With regard to the tonnage of the steam trawlers in 1883, as well as at the present time, the returns of the Board of Trade give only the nett tonnage, which is very misleading as to the size of the vessel, owing to the deductions from gross to nett of the space occupied by engine space and coals. These deductions have increased from 1883 up to the present time on account of the increased power demanding larger space. In many instances a gross tonnage 180 is now reduced to 50 nett, whereas in 1883 a gross tonnage of 100 would not be reduced to less than 50. These figures apply to Grimsby and no doubt to most ports. The average gross tonnage here at the present time will be 150 tons, whereas in 1883 it did not exceed 100." (cf. McIntosh, *Resources of the Sea*, p. 59.)

From these quotations it is clear that, in Mr. Alward's opinion, the relative efficiency of the modern steam trawler compared with the smack is about eightfold (*i.e.* twice the relative efficiency in 1883). Other correspondents, all of them being smack-owners or men equally familiar with the practical side of the trawling industry, have assigned a catching power to the modern steam otter trawler of from at least sevenfold to at least tenfold the power of the sailing trawler. The grounds for their opinions are various, and need not be detailed. The limits which they assign show that Mr. Alward's opinion is by no means an exaggerated one, and that it forms indeed a kind of average of the views generally held by practical men.

Now a considerable portion of the increase in the catching power of the steam trawler is due to the exchange of beam for otter trawls in 1895, and it is shown below that this change of fishing gear has increased the catches of steam trawlers by 37 per cent., or, approximately, one-third of the total, *i.e.* has multiplied the catching power by one and a third.

If this deduction be made from the gross catching power of the otter trawler (estimating the latter at eight times the catching power of the sailing trawler), we obtain a figure which approximately represents the relative efficiency of the vessel less the advantages recently conferred on it by the adoption of the otter trawl. Assuming for a moment the accuracy of the foregoing estimates (which will be dealt with in greater detail below), we thus find that the modern steam trawler, if fitted with beam trawls, would catch approximately six times as much fish as the average sailing trawler, an increase in efficiency of 50 per cent. since 1883–5, viz. from fourfold to sixfold.

Now, according to Mr. Alward's figures, the gross tonnage of Grimsby steam trawlers has increased by exactly the same amount in the interval; and, on working out the average of the registered tonnage of English steam fishing vessels from the data given in the Annual Statements of Navigation, I find that precisely the same increase has taken place in the average registered—or nett—tonnage, viz. from 34 tons in 1884 to 52 tons in 1898.

We may therefore conclude that the efficiency of steam trawlers, apart from the question of the otter trawl, has increased *pari passu* with the increase in their average registered tonnage, or rather with the increase in the registered tonnage of English steam fishing vessels in general, the great majority of which, however, are steam trawlers. If therefore for each year since 1884 the average registered tonnage be plotted out, and the relative efficiency of the steam trawler be placed at four for 1884 and six for 1898, the rate of increase in the efficiency during the period may be obtained in proportion to the rise in tonnage. This has been done in Table X. The result is, briefly, that in 1889 the efficiency was fivefold that of the smack, and in 1893 five and a half times.

TABLE X., *showing the increase in Average Registered Tonnage of English Steam Fishing Vessels, and the increase in Relative Efficiency of Steam Trawlers, from* 1884 *to* 1898.

	1884	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
Average tonnage .	34	42	45	48	48	48	48·5	49·5	50	51	52
Efficiency (beam trawls)	4	5	5·25	5·5	5·5	5·5	5·6	5·7	5·8	5·9	6
Otter trawls (factor).	—	—	—	—	—	—	—	1·1	1·2	1·3	1·3
Total efficiency .	4	5	5·25	5·5	5·5	5·5	5·6	6·3	7	7·7	8

The only means at my disposal for verifying the accuracy of these conclusions is to compare the average catch of Scottish steam trawlers during 1893 and 1894 with the probable catch of Grimsby sailing trawlers for the same years. The admirable statistics of the Scottish Fishery Board show, when worked out for this purpose, that the average annual catch of Scottish steam trawlers landing fish on the East Coast in the years 1893 and 1894 amounted to 3,802 cwts. per vessel (see Table XI.). From the average catch of Mr. Alward's sailing trawlers for 1890–2, as well as from the figures for Lowestoft trawlers already cited for 1892 (p. 45), we may infer that their catch in the two following years would probably average not more than from 700 to 900 cwts. per vessel. Comparison of the two sets of figures yields a relative efficiency for the Scottish steam trawlers between 4·2 and 5·4. The efficiency of English steam trawlers for the same years is calculated to have been from 5·5 to 5·6 (Table X.). Seeing that the average registered tonnage of the Scottish vessels only amounts to 32·5 tons for the years in question, whereas the average tonnage of English steam vessels was from 48 to 48·5 tons, we may justly conclude that the average English steam trawler at that time was a more powerful vessel than the type prevalent in Scottish waters, although exact comparison is impossible, owing to the inclusion in the English figures of a certain number of steam carriers and liners, which no doubt affect the figures to some slight extent. Under these circumstances the close correspondence between the estimated efficiency of the Scottish East Coast steam trawlers and of the English vessels for the years 1893 and 1894 may be regarded, if not as an actual verification of the accuracy of Mr. Alward's estimates, at any rate as a substantial proof of their freedom from serious exaggeration.

I conclude, therefore, that in order to convert the number of English steam trawlers into their smack-equivalents for each of the years from 1889 to 1894, the figures in Table X., which represent the relative efficiency of the steam trawlers for those years, may be treated as factors by means of which the conversion can be effected on an approximately accurate basis.

§ iii. *Otter Trawls on Steam Trawlers.*

In 1894, however, the otter trawl was introduced, and the extent of the change in catching power which its rapid adoption in 1895 wrought among steam trawlers must now be examined.

Mr. Cunningham has stated that in the opinion of Hull fishermen the otter trawl increased the catches of steam trawlers in 1895 by as much as 50 per cent., and various correspondents engaged in the fishing industry, to whom I have put the question, have agreed in estimating the increase in the total catches as from 33 per cent. to 50 per cent., the catch of round fishes alone having been even doubled.

The relative efficiency of the otter and beam trawls as worked by steamers can be measured, however, in a reliable manner without recourse to personal opinions. It happens that the trawlers landing fish on the East Coast of Scotland have been exclusively steamers for some years past, and the aggregate catches of these boats, together with the number of vessels at work, are given in the Annual Reports of the Scottish Fishery Board. There are usually about a hundred steam trawlers working annually from Aberdeen and other East Coast ports. The otter trawl having been introduced at Granton in 1894, and rapidly adopted by steam trawlers in general during the course of 1895, the changes wrought by its adoption can be clearly determined by comparing the average catch per trawler for a year or two prior to 1895 with the average catch per trawler for the years immediately following 1895, the year of transition being of course omitted.

TABLE XI., *showing the Total Catches of Scottish Steam Trawlers for two years before and after the introduction of the Otter Trawl in* 1895.

	Trawlers.			Aggregate Catch (cwts.).				
	Number.	Tonnage.		Cod.	Haddock.	Lemon Sole.	Flounder, Plaice, and Brill.	Total.
1893.	111	3,584	...	52,965	241,762	17,018	45,744	421,410
94.	115	3,770	...	72,778	259,168	17,656	46,711	437,815
1896.	104	3,524	...	107,139	319,013	18,357	54,132	545,652
97.	112	3,795	...	124,576	349,742	13,010	41,531	583,212

TABLE XII., *showing the Average Annual Catches per Boat (cwts.) of Scottish Steam Trawlers,* 1893 *to* 1897, *and the Relative Efficiency of the Otter and Beam Trawls deduced therefrom.*

	Average Tonnage.	Cod.	Haddock.	Lemon Sole.	Plaice, etc.	Total (cwts.).	
1893 . .	32·3	477	2,178	153	412	3,796	Beam trawls.
94 . .	32·8	533	2,254	153	406	3,807	
1896 . .	33·9	1,030	3,067	176	525	5,247	Otter trawls.
97 . .	33·9	1,112	3,123	116	371	5,207	
1893–4 . .	32·5	505	2,216	153	409	3,802	
1896–7 . .	33·9	1071	3,095	146	448	5,227	
Relative efficiency of Otter		2·12	1·35	0·95	1·10	1·37	

The results of a comparison on these lines are set forth in Tables XI. and XII. It will be seen that the aggregate total catches in 1893 and

1894 were much less than the corresponding catches in 1896 and 1897, although the number of vessels at work during the latter years was slightly less. For the first two years the average total catch per trawler amounted to 3,796 and 3,807 cwts. respectively; for the last two years to 5,247 and 5,207 cwts. respectively—a difference which can only be attributed to the change from beam to otter trawl. If the average catches for each pair of years are combined, we find that the average annual catch of the beam trawlers was 3,802 cwts. and of the otter trawlers 5,227 cwts.—a difference which yields a relative efficiency in favour of the otter trawl amounting to 1·37 times that of the beam trawl, or, in other words, an increase of 37 per cent. on the total catches.

In regard to the different kinds of fish, the table shows that the otter trawl caught more than twice the quantity of cod, 35 per cent. more haddock, and about the same quantity of flat-fish as was obtained by the beam trawl in each case. These figures certainly do not overstate the efficiency of the otter trawl, since the years 1893 and 1894 were notorious for the exceptional abundance of haddock on the East Coast of Scotland, while the remarkable fall in the catch of flat fishes, both lemon soles and plaice, in 1897 suggests that the quantity of these fishes caught in the second period was below the average in consequence of exceptional scarcity. This reduced catch can scarcely be attributed to the change of fishing gear, otherwise the catch in 1896 would have shown the same depression.

It makes, however, no material difference in the resultant averages whether we take 30 per cent. or 40 per cent., or any intermediate figure, to represent the increase in catching power due to the adoption of otter gear. The figure already chosen for deducing the tonnage efficiency was, for convenience, 33 per cent.; and in order to make full allowance for the time required for the supersession of the beam trawls on English steam trawlers, I have assumed that only one-third of the increased efficiency (10 per cent.) came into operation during the year of transition (1895), and only two-thirds (20 per cent.) during the following year. For 1897 practically the full efficiency (30 per cent.) has been allowed, and for 1898 of course the power of the otter trawl has been included in Mr. Alward's estimate of the gross catching power of the modern steamer, which there is every reason to believe is approximately correct (cf. Table X., p. 48).

For evidence as to the introduction of the otter trawl reference may be made to the full account given by Mr. Cunningham* in this Journal in 1896 (vol. iv. pp. 114–21). Mr. Scott's patent modification of the otter gear was fitted to some of the Granton Steam Fishing Company's vessels in June, 1894, but it was not until the summer of 1895 that the new gear began to be generally adopted by English steamers. During his visit to Hull in August, 1895, Mr. Cunningham was informed by Mr. Scott that the patent gear was then in use on sixteen or seventeen steamers in that port, on eight in Granton, on one at Boston, two at Grimsby, and two at Milford Haven, and Mr. Cunningham saw it on one in Scarborough earlier in the same month. In addition to these vessels, a large number of steamers were also fitted with otter trawls of a somewhat different construction; but there is no available means at present of determining the total number of steamers which had adopted the new gear by any particular date in the year. There is, however, abundant evidence that as soon as the advantages of the beamless trawl became generally understood the exchange was effected with great rapidity. Mr. Ascroft, of Lytham, informs me that he was with the Red Cross fleet (Hull) on the Dogger when the otter trawl was first tried there, on the steam trawler *Madras*, and that the difference between the catches of this vessel and the steam beam trawlers was so great that, as the boats went back to Hull for coal, they were not sent out again until they had the otter gear fitted, even if it took a week or ten days.

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* Cf. also McIntosh, *Resources*, pp. 65 and 91; Tenth Report of the Inspectors of Sea Fisheries, England and Wales, for 1895, pp. 11, 121 (Hull), and 121 (Milford); Reports of the Scottish Fishery Board, xiv. p. vii.; xv. p. ix.

§ iv. *Relative Efficiency of Liners.*

For estimating the catching power of the line fishing-boats (first class) I am compelled in the present essay to depend upon evidence which probably yields nothing but a rough approximation to the true values, since precise information upon the point has been unavailable. One difficulty arises from the fact that the sailing liners frequently devote themselves to the herring fishery during the summer months; and, although this custom of combining two methods of fishery is more especially found among the smaller boats, there is little to show to what extent the custom prevails among vessels of the first class, to which my statistics are limited.

In the Report of the Sea Fishery Commissioners of 1879 (Buckland and Walpole, p. 133) it is stated that the total annual catch of sixteen large liners at Staithes might be estimated at 1,400 (2,000 – 600) tons—an average of 87 tons per vessel. This figure, however, includes the produce of the summer herring fishery from June to October. If a deduction of from one-half to two-thirds of the total catch be made to cover this item, the catch of bottom fish per vessel is reduced to an average of from 29 to 43 tons. At this period the Grimsby trawlers were catching from 45 to 60 tons per vessel.

Even the catch of the Grimsby codmen must be below that of the trawling smacks, for it was stated at Grimsby in evidence before the Royal Commission of 1863 that "a trawl smack as a rule will catch a greater weight of fish than a liner, but it is of less value" (§ 15,932).

At Billingsgate, before the same Commission, it was stated, even at that time, that the "liners did not bring more than 10 per cent. (5 per cent. to 10 per cent.) of the fish coming to this market" (§ 12,862); and again, "A trawler catches ten times the weight of fish obtained by a line boat, day for day, or year for year, taking the twelve months round" (§§ 12,867–8).

This latter estimate no doubt refers to the average catch of all line boats, large and small.

A similar contrast exists between the catches of the modern steam trawlers and liners. Thus in March of the present year, ten Aberdeen steam liners were reported to have landed 28 tons of fish at one time, *i.e.* an average of 56 cwts. per boat per voyage. Simultaneously thirty-six steam trawlers at the same port landed 250 tons—an average of 138 cwts. per boat per voyage (*Fish Trades Gazette*, March 31st, 1900, p. 17). Thus the average catch of the steam liner was only two-fifths as great as that of the steam (otter) trawler, if we assume that the voyages made by the two classes of boat were of equal duration. In view, however, of the liner's dependence upon bait, this assumption is not likely to be strictly correct, even in these days of ice and preserved bait. Moreover, as the number of steam liners during the decade has not increased at the same rate as the number of trawlers (twofold instead of fourfold), it is necessary to ensure that their catching power shall not be under-estimated, since any serious deficit would reduce the estimated total catching power to a greater extent in the earlier than the later years, and so conduce towards a spurious fall in the estimated average catches.

If, therefore, we allow to the steam liner a catching power of three-fourths that of the otter trawler, any error in the estimate is likely to be rather in the nature of an exaggeration of the true efficiency than otherwise. This would be equivalent in 1898 to the catching power of six sailing trawlers—that is to say, it would be practically identical with the estimated catching power of a steam trawler fitted with beam, instead of otter, trawls (see Table X., p. 48). Assuming that the efficiency of the steam liners has increased during the decade in proportion to the increase in average registered tonnage, the same factors may therefore be applied to the numbers of steam liners as to the steam beam trawlers, in order to convert their catching power into the proper number of "smack-equivalents." The results of this conversion are set forth in Table F (p. 68). The aggregate catching power of the steam liners is there seen to have nearly trebled in 1897 as compared with 1889, but fell considerably in the following year, owing to the reduction of the number of steamers engaged in line fishing.

For a similar reason the average catching power of the sailing liner (first class) is assumed to have been four-fifths that of the sailing trawler throughout the decade, although the evidence cited above points rather to a lower coefficient as more strictly correct.

4. Total Catching Power of Bottom Fishing Boats.

The total catching power of the first class vessels engaged in catching "bottom fish," as derived from the various sources already discussed, is set forth in Table H (p. 69). Each year of the decade 1889 to 1898 is separately distinguished, and the catching power devoted to the North Sea fisheries is separated from that engaged in the South and West Coast industry.

The catching power of all vessels, whether trawlers or liners, and whether steamboats or smacks, is there expressed in terms of "smack-units," the various computations for which have already been described.

For the East Coast the catching power is seen to have increased continuously during the decade, from a power represented by 2,859 trawling smacks in 1889 to the power of 7,143 smacks in 1898, the catching power having nearly trebled during the period.

For the South and West Coasts the power is seen to have doubled during the decade, from the equivalence of 946 smacks in 1889 to that of 1,896 smacks in 1898. But the increase is seen to have been far from uniform, as the rise up to 1892 was followed by a fall during the next two years, to be succeeded by a steady and conspicuous rise to the end of the period. These irregularities are principally due to the invasion of the Western waters by East Coast vessels, both steamers and smacks, about the time of the opening of Milford Docks in 1889. These yearly immigrations fell off to a large extent after a few years, the smacks first of all, on account of their excessive size, and the steamers after 1892. The remarks made in an earlier section (p. 41) as to the figures representing the East Coast steam trawlers in this table should be borne in mind (see also pp. 62–4).

For the Entire Coasts of England and Wales the catching power is shown to have steadily increased from 3,675 smack-units in 1889 to 8,503 units in 1898, the power at the end of the decade being two and a third times that at the beginning.

5. Average Annual Catch per Unit of Catching Power.

The results obtained by distributing the total weight of fish landed on the different coasts among the corresponding number of smack-units estimated for each year of the decade are set forth in Table VIII. (p. 34).

For the **East Coast** fisheries there was a steady increase, both in the weight of fish annually landed and in the catching power devoted to the industry. **But whereas the increase in fish amounted to only about 30 per cent. during the decade, the catching power nearly trebled in the same period.** The result is that for each unit of catching power the average annual catch has fallen from 60·6 tons in 1889 to 32·3 tons in 1898. The fall was rapid both in the three first and three last years of the decade, but the three middle years of the decade (1893, 1894, and 1895) maintained practically the same average as the year 1892, showing even a minute increase in 1893 and 1894.

The year 1893, it will be remembered, was characterised by two features, each of which probably exerted a special influence on the East Coast fisheries, viz. the exploitation of the Iceland trawling grounds and an exceptionally long warm summer—the warmest spring,* according to the Reports of the Meteorological Office, for a period of thirty-three years at least. To these may perhaps be added an increased activity (after a period of self-imposed abstinence) of the trawlers on the Eastern grounds, whence large quantities of small fish were landed in that year (Eighth Report of the Inspectors of Sea Fisheries, p. 11). Each of these circumstances must have contributed to swell the catches in 1893, the first and third directly, and the second by its effect on the inshore migrations of flat-fish, and on the rate of growth of these as well as of other bottom fishes.

These suggestions are confirmed by a study of the Board of Trade's returns of the quantities of the different kinds of fish annually landed on the East Coast. Since 1888, the year when the statistics for plaice were first distinguished, there have been only two years in which the returns of sole, turbot, plaice, and brill have all increased beyond the returns for the previous year, viz. 1891 and 1893. But the increase of plaice in 1893 was unequalled within the period, and greatly exceeded the increase in 1891, the total catch rising suddenly from 621,000 cwts. in 1892 to nearly 759,000 cwts. in 1893, the previous maximum having been 648,000 cwts. in 1891. This exceptional increase was not due to any unusual increase in the catching power. Indeed, as the weather in 1893 was unfavourable to the voyages of sailing vessels (from lack of wind in the summer, and winter gales), the relative increase in catching power, so far as the shallower waters are concerned, should probably be less rather than more than the increase shown in my tables, a fact which renders the general increase in the quantities of flat fishes landed all the more remarkable. The Iceland catches no doubt contributed largely to increase the captures of plaice, but could have no effect upon the supply of soles, turbot, and brill; so that the general increase of all kinds of flat fishes in 1893 must be attributed largely to the favourable effects of the hot spring and summer in the manner suggested above. The reports of the collectors of fishery statistics at Lowestoft and Ramsgate, and the returns made to the Board of Trade by the Sea Fisheries Committees, strongly corroborate this view (see Report of the Inspectors).

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* See Table G (temperatures), p. 68.

In any case, the abnormal increase of flat fishes in 1893 is sufficient in itself to show that exceptional influences were at work in 1893 tending towards an increase in the trawlers' captures. Consequently the temporary cessation in the fall of the average catches shown by my table for this year is in accord with the independent evidence from other sources, and to that extent confirms the accuracy of my results.

An explanation of a similar kind, though differing in details, appears to me to account for the maintenance of the average catches at about the same figure during the next two years. The catches of plaice and brill were about the same in 1894 as in 1893, and the catches of soles and turbot still further increased. The weather was favourable for smacks; more vessels visited the Iceland grounds; and the good effects of the warmth of the previous year on the reproduction, food-supply, and rate of growth of fishes were not yet exhausted. Haddocks, the young stages of which had been exceptionally abundant* during the previous year, were taken this year of larger size and in abnormal quantities. The *increase* of haddocks in 1894 amounted to 200,000 cwts.; in 1893 it was only 50,000 cwts.; in 1892, 150,000 cwts.; in 1891, the same. This is but an illustration of a phenomenon well known to fishermen, that an exceptional abundance of young fish in one season is usually followed by larger catches of the same species in the following year; but the importance of the fact in this case is in the evidence it affords of the far-reaching effects of the exceptionally favourable season of 1893.

In 1895 the abundance of haddocks was still maintained, the increase over 1894 amounting to 250,000 cwts., a result which, though partly attributable to the introduction of the otter trawl, was principally a consequence of the same climatic cause as the increase in 1894. Since 1895 the annual increments in the catch of haddocks have markedly diminished in spite of the otter trawl and its great catching power, the annual changes having been an increase of 110,000 cwts. in 1896, a decrease of 20,000 cwts. in 1897, and an increase of 60,000 cwts. in 1898.

Turning now to the estimated average catches for the bottom fisheries of the **South and West Coasts**, two remarkable differences are presented between the results of these fisheries and those of the East Coast. The catches are much less in amount, and are remarkably constant throughout the period. Nevertheless it is noteworthy that a slight fall in the first few years is followed by an increase in 1893 and 1894, which is again succeeded by a continuous fall until the last year of the decade, which is marked by a moderate increase. The figures, therefore, appear to show, on the whole, that the abundance of fish on the grounds is slightly decreasing, though subject to temporary increases under the influence of particularly favourable seasons.* (N.B.—See below, pp. 62–4.)

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* *Fourteenth Report of the Scottish Fishery Board*, p. 145; McIntosh, *Resources*, p. 194.

The average catches for all coasts together naturally display the same predominant features as the East Coast fisheries, though the catches are lower than those for the East Coast alone for all except the last years of the decade in consequence of the depressing effect of the inclusion of the figures for the South and West Coasts.

6. Reconsideration of the Methods and Results.

As this is the first detailed attempt which has been made to present a statistical review of the condition of the English trawl fisheries, and as the basis upon which it depends has necessarily been of a limited character, there can be no doubt that in various details my computations need correction and modification. If more authentic lists of the different kinds of fishing boat were available, if the products of the trawl and line fisheries were distinguished in the fishery statistics, and if smack-owners from a larger number of centres would co-operate by providing information as to the actual annual catches of their vessels on different grounds, I believe the method which has been followed in the present essay could be relied upon to provide unquestionable evidence concerning the condition of the fishing grounds. The whole question of fishery statistics is now, I understand, under consideration by the Board of Trade. We may therefore reasonably expect that more exact information will in due course be provided as to the numbers and size of the vessels engaged in the different fisheries, and that the reiterated demand for a separation of the products of the different fisheries in the Board's annual statements will receive the attention it deserves. Of the willingness of the smack-owners to co-operate when the importance of their assistance becomes apparent I have no doubt.

In the present essay, however, it is by no means certain that the results arrived at in the case of the different coasts are of equal value. The fundamental assumption in my calculations is the catching power of the sailing trawler and the relative catching power of the steam trawler in comparison with it. From the absence of positive information as to the average weight of fish landed by smacks on the South and West Coasts, I have been compelled to use the same coefficients for these coasts as for the East Coast. The evidence submitted in the earlier portions of this paper seems to me to show that for the East Coast those coefficients are approximately and sufficiently correct; but the low averages which result from the application of the same factors to the boats of Western ports appear to demonstrate that the relative catching power of steamers and smacks in these waters is not the same as for those of the East Coast (cf. p. 62).

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* For evidence of the remarkable effect of the weather in 1893 upon the fauna of Plymouth Sound, see this Journal, vol. iii., 1894, pp. 210–11. For its effects on the reproduction of the oyster, see Herdman in *Nature*, July, 1893, p. 269. For the exceptional abundance of haddock in the Irish Sea in 1894, see *Ninth Report of the Inspectors of Sea Fisheries*, pp. 16, 155, 157, etc. The summer in 1898 was exceptionally hot, as in 1893; and, although the spring was normal, the autumn was the hottest for thirty-three years (see Table G).

It is, however, first of all necessary to determine the degree of error which is introduced into the results by dividing the whole catch of bottom fish among the first class boats alone. Part of this catch is, of course, derived from small trawlers and liners, and it is conceivable that changes in the quantity of fish landed by the smaller boats might seriously affect the averages which have here been assigned to the larger boats alone.

In the middle of the period (viz. 1893) the gross number of second class liners fishing from the East Coast ports as determined from the returns of the collectors of fishery statistics was, approximately, 650. The number of second class trawlers engaged in inshore fishing was about 300, or 500 if we include the shrimpers of Yarmouth, Gravesend, etc. Many of these boats are engaged in the line and trawl fisheries for a limited portion of the year, and, of course, the weight of fishes actually landed by the shrimpers is infinitesimal. Taking, however, the total of these small boats at about 1,000, and allowing them an average catch amounting to one-tenth that of a deep-sea trawler (see above, p. 53), we may estimate the total catch of bottom fish derived from these sources as 80,000 cwts., or 4,000 tons. If this amount be deducted from the total quantity of bottom fish landed on the East Coast in 1889 and 1898 respectively, the remainder, when distributed among the estimated number of smack-units for those years, yields an average catch per unit of 58·9 tons in 1889 and 31·7 tons in 1898. The differences between these averages and those given in Table VIII. (p. 34) are so minute that no serious error in my results can be attributed to this source.

The next point to examine is the discrepancy between my estimated averages per smack-unit for the **East Coast** and the actual catches of the Grimsby and Lowestoft smacks for the same years. The only figures available are for the first four years of the decade, and are as follows:—

	Catch per Unit.	Grimsby Smacks.	Lowestoft Smacks.
1889 . . .	60·6 ...	32·6 ...	—
90 . . .	55·7 ...	36·1 ...	—
91 . . .	48·5 ...	46·0 ...	—
92 . . .	46·2 ...	34·1 ...	42·4

For the last two years in this table my estimated averages are in substantial agreement with the actual catches of the smacks. How is it that my earlier averages are so much higher than those of the Grimsby smacks?

In the first place it should be noticed that all my averages for the above four years are in excess of the actual catches of the smacks. This appears to indicate either that the total catch of bottom fish has been exaggerated by the collectors of statistics, or that my estimates of the catching power are inadequate. If the exaggeration of the catch, or the under-estimation of the catching power, were uniform throughout the period, this would not materially affect the value which my averages possess in showing the rate at which the depletion of the North Sea grounds has been proceeding. Consequently we may limit the inquiry to the question whether there is any reason to regard the Board of Trade's statistics of fish landed, or my estimates of the catching power, as of unequal value during the years in question.

Concerning the first point, there is no doubt that in the earlier years of the fishery statistics the catch of fish was unduly exaggerated. In the *Statistical Tables and Memorandum for 1889* it is stated (p. 4) that the great falling off in the Board's Returns of Prime Fish landed was largely nominal only, and arose from increased accuracy in the methods of collecting the returns. The returns of Prime Fish for the first few years in thousands of hundredweights, were as follows: 1886, 503; 1887, 235; 1888, 206; 1889, 118; 1890, 133. The fall during those early years was certainly enormous, and the degree of error correspondingly large, after all allowances for depletion of the grounds. But my calculations do not include those years, and from 1889 onwards for a considerable number of years the Board's returns for Prime Fish steadily increase, which appears to imply, as has indeed been officially stated,* that at any rate from 1889 onwards the greater experience of the collectors, and the more accurate methods introduced, render the Board's returns sufficiently reliable for comparative purposes. Consequently, so far as an opinion can be formed from the internal evidence of the returns, and the official statements of the Board, it is very improbable that the fall in my estimated averages can be considered as exclusively, or even largely, due to inaccuracies in the Fishery Statistics for 1889 and 1890, especially as my averages again fall by equal amounts in the latter years of the decade when the fishery statistics may be regarded as free from extensive errors of the kind contained in the earlier years of their publication.

As regards the possible errors in my estimates of the total catching power, this can best be examined by considering the whole series of years together; for if the decline in the estimated averages during the decade is to be attributed to errors in the estimated catching power, these errors must include an over-estimation of the catching power in the later years as well as an under-estimation in the earlier years.

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* Cf. Mr. Berrington, Minutes of Evidence, Select Committee, 1893, §§ 2,435, 3,083.

The fall in the averages is so great that any errors responsible for the fall must be of equally great magnitude. The average of the estimated catches per unit amounts to 46·5 tons for the decade. To reduce the average catch for 1889 to this amount would need the addition of 865 smack-units (=173 steamers) to my estimated total for the year. It is certain, however, that, so far as the steamers are concerned, the error in my estimates is rather an exaggeration than an under-estimation, for no deductions have been made for steamers working on the South and West Coasts, and further deductions should probably have been made for additional Hull and Grimsby carriers. Moreover, whatever minor errors occur in my list of the trawling smacks, they certainly do not amount to anything like an omission of the number above mentioned, which is exactly one-half of my estimated total of trawling smacks for 1889 (Table E, p. 67).

The same argument applies to the figures for 1898. To increase the estimated average catch to the average for the decade would need the withdrawal of 2,183 smack-units (=273 steam trawlers) from my estimated total. The former number actually exceeds the number of smacks estimated for the East Coast in that year, while we have already seen (p. 41) that an estimate of sixty-seven steamers working on the West Coast in that year is probably excessive. The gross number of fishing steamers is, of course, accurately known from the Register of British Ships, and my figures are based upon those in the Register.

It is impossible, therefore, to ascribe the fall in the average catches to sufficiently serious errors in the number of fishing boats.

The remaining estimates which contain sources of error in my figures are the factors indicating the relative catching power of the steam trawlers and of the liners. The sailing liners may be omitted from consideration: their small numbers and the high catching power already assigned them render it certain that no error in connection with them can contribute seriously to the discrepancy in the annual averages. The steam trawlers and liners may be considered together, since for the first six years their efficiency has been considered as identical. The coefficients for the conversion of steam trawlers to their equivalents in smacks are based on a comparison of the catches of both classes of vessels in 1883–5, but especially the latter year. There can be no doubt, from an examination of the yearly averages of Mr. Alward's smacks, that the catches assigned to the smacks at the period in question were above the average. The increase in 1882 and 1883 has been explained as due to an exceptional extension of the fleeting period; but even after the latter year, when the fleeting period was reduced to its normal duration, the catches were higher in 1884 and 1885 than during all the subsequent years included in the table, and were even higher than for a number of years prior to 1882. Consequently there is some ground for believing that my coefficients for steam trawlers may be below rather than above the true index of their catching power as compared with that of smacks.

It must be admitted, therefore, that part of the excess in the average catches per unit for 1889–92 over the average catches of the Grimsby smacks for the same years may be attributed to a slight under-estimation of the relative efficiency of the steam trawler. The error, however, thus caused in the amount of the factor is merely a fractional one, and, owing to the great preponderance of sailing vessels at this period, is insufficient to produce more than an insignificant reduction in the average catch per unit during the earlier years of the decade; whereas the least addition to this fundamental factor produces a far more considerable effect in the later years of the decade, when smacks had decreased in numbers and steam trawlers had greatly increased both in numbers and catching power. If, therefore, my coefficient for steam trawlers at the beginning of the period is regarded as seriously inadequate (which, I confess, does not appear to be the case), and is raised accordingly, the averages at the beginning of the decade will be undoubtedly reduced, *but the averages for each successive year will also be reduced to a still greater extent*, and the decline in the average catches of North Sea vessels per unit of catching power will be shown to be greater than is actually revealed by my figures.

On the other hand, if my estimates of the increase in the average catching power of steam trawlers (Table X., p. 48) are based on insufficient data (and I admit the desirability of ampler confirmation), the error arising from this source is also inconsiderable, as may be seen by taking the efficiency of the steamers as a constant quantity throughout the period, subject only to the verifiable increase due to otter gear. Assuming this efficiency to have been fourfold that of the smack (see Table IX.) up to 1895, rising to 5·2-fold in 1898, we still get a considerable difference in total catching power of East Coast vessels between 1889 and 1898, viz. from 2,673 units in 1889 to 5,029 units in 1898. These figures yield an average return of 64·8 tons of fish per unit in the former year as contrasted with 45·8 tons in the latter year. The rate of fall is reduced by this alteration, but the decrease is by no means eliminated, since it exceeds an average of one ton of fish per unit per annum.

Accordingly, from the data available, I can discover no error of sufficient magnitude to account for the yearly decline in the average catches which my table reveals. The discrepancy between my estimated averages for 1889 and 1890 and the actual averages of Mr. Alward's smacks for the same years should probably be attributed to the incidental differences which cannot fail to manifest themselves between the averages of a few sailing vessels working upon a small portion of the field and the averages derived from all boats over the entire North Sea area. The difference between the averages of the Grimsby and Lowestoft smacks in 1892 is sufficient to indicate the extent of the variations which must be expected in any year in the catches of sailing vessels working upon different and limited grounds. The catches of sailing vessels cannot, of course, do more than indicate the fluctuations in the fishery on the grounds frequented by the vessels. My estimated averages, however, profess to indicate the relative fluctuations in the fishery over the entire region of the North Sea visited by steamers and smacks alike.

Owing to the fact that the catch per unit was assumed to have been 961 cwts. (=48 tons) in 1885, my figures would appear to indicate that between that year and 1889 a rise took place in the general averages, possibly in consequence of the exploitation of new grounds by the steamers. It is of course perfectly possible that the amount of this rise has been exaggerated by the mode of determination adopted in this essay and by the multiplication of small errors in the assumptions which have been made. To this I can only reply that it is improbable that irregularities of this kind should affect the figures in the same direction throughout the decade, especially when every precaution has been taken under each item in the calculations to prefer such alternatives (where any choice was presented) as would prevent underestimation of the catching power in the earlier years and exaggeration of the same in the later years of the decade.

But in regard to the averages for the **South and West Coasts**, the figures which represent them are so far below the actual catches of the Grimsby smacks at the beginning of the period, and yet are so uniform throughout the whole period, that I cannot place the same confidence in the results. It has already been pointed out that an exceptional difficulty occurs in regard to this area in consequence of the number of North Sea vessels which have visited these waters during the period under consideration, and the probability that the numbers which I have assigned to them are excessive both in consequence of the method of determination and of the uncertainty as to the length of their sojourn. The extent of the error introduced from this source may best be determined by comparing the averages in Table VIII. (p. 34) with the corresponding averages derived from a distribution of the total catch of fish among the local vessels alone. For 1889 my estimate of the local trawlers belonging to ports on the South and West Coasts (see Table H, p. 69) yields 46 steamers and 546 smacks—a total of 776 smack-units. For 1898 I estimate 100 steamers and 525 smacks, *i.e.* 1,325 smack-units. The average catch per unit yielded by these figures is 36·9 tons in 1889 and 41·5 tons in 1898. As there is no doubt, however, that the actual catching power should include a considerable number of North Sea vessels, it is quite clear from these figures that the error introduced by my estimates of their numbers does not account for the low average catches as compared with those of the Grimsby smacks; for not only are the averages for the early years increased to a small extent only, but the slight evidence of a fall in the averages which is yielded by the figures in Table VIII. is altogether swept away by the exclusion of the North Sea vessels from the total catching power. It is therefore certain that the relative catching power of steamers and smacks on the South and West Coasts is not the same as on the East Coast, *i.e.* the actual catches of smacks on the former coasts are not so great as those of the East Coast vessels, and the factors which are applicable to the East Coast statistics are inapplicable to those of the South and West Coasts.

I have indeed been assured by smack-owners of Western ports that the relative catching power of steamers on these coasts is now at least ten to one as compared with smacks, but from absence of positive data as to the actual weight of fish landed I am unable to give the precise ratio. Nevertheless the establishment of this point is of great importance, for it will be seen from a study of Table H that any increase in the relative efficiency of steamers over smacks in this region must have the effect of depressing the average catches to a greater extent in the later than in the earlier years of the decade, owing to the great increase in the proportion of steamers to smacks during the decade. This increase holds whether we consider the local vessels alone or the totals of the local vessels and the estimated numbers of North Sea visitors. The consequence is that the slight fall in the average catches shown in Table VIII. for the South and West Coasts is less than the fall which has actually occurred,* so that for these coasts there is no escape from the conclusion that during the past ten years there has been an indubitable fall in the average catches of the trawling vessels per unit of catching power, though of less extent than for the East Coast. This proof, which is largely independent of personal opinions, of the progressive impoverishment of the fishing grounds has all the more force when it is remembered that the period has been characterised by increasingly warm weather, and includes one year at least in the middle of the period (1893) which was exceptionally favourable for the reproduction and growth of fishes on almost all our coasts. The influence of this year should have increased the catches in the second half of the decade as compared with the first, and there is some evidence that a favourable effect was temporarily manifested. But the fact that, according to my figures, even the occurrence of so exceptionally favourable a year in the middle of the decade did not arrest the decline in the average catches for more than two or three years tends to show that the rate at which sea fishes reproduce and grow is no longer sufficient to enable them to keep pace with the increasing rate of capture. In other words, the bottom fisheries are undergoing a process of exhaustion.

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* See figures on next page.

The following figures have been prepared to show the annual growth of catching power and the average catch per smack-unit for the South and West Coasts, if we assume the relative efficiency of steamers in 1898 to have been tenfold (instead of eightfold) that of smacks, and if the efficiency factors for the previous years be multiplied to the same extent (*i.e.* by 1·25). The other items, as given in Table H., II., have not been changed.

Year.	Smack-units.	Catch per unit.	Year.	Smack-units.	Catch per unit.
1889	1,036	27·6	1894	1,204	28·1
1890	1,186	27·8	1895	1,420	25·8
1891	1,190	24·2	1896	1,755	23·2
1892	1,424	23·7	1897	2,092	21·9
1893	1,308	25·8	1898	2,230	24·7

These figures are alternative to those given in Table VIII., p. 34, and probably represent more accurately the amount of the fluctuations in the trawl fishery during the decade, although the general features are the same in both cases (see pp. 56, 57).

In conclusion, I may state that if smack-owners and steamer-owners will kindly assist me with detailed returns of the annual catches of their vessels for individual years, or for any series of years, I will gladly prepare a revised edition of the tables in this paper, based upon such new information. Needless to say, the value of conclusions drawn from calculations of this kind depends entirely on the basis of fact underlying them.

TABLES A–D, *showing the Weight of Fish annually landed, and the Value realised, by four Grimsby Trawling Smacks for each year from* 1875 *to* 1892.

TABLE A. SAILING TRAWLER "ANGELUS."

YEAR.	PLAICE.		HADDOCK.		"PRIME."		"ROUGH."		TOTAL.	
	cwts.	£	cwts.	£	cwts.	£	cwts.	£	cwts.	£
1875	585	300	727	419	80	223	26	24	1418	967
1876	531	254	781	387	53	149	21	20	1386	810
1877	434	228	589	286	146	408	18	17	1187	929
1878	250	152	394	207	106	298	33	31	783	787
1879	264	146	258	110	45	128	11	10	578	394
1880	279	153	343	138	87	242	36	34	745	568
1881	242	172	244	102	84	314	60	57	630	645
1882	308	212	488	147	104	393	70	68	970	819
1883	282	220	604	207	93	346	77	71	1056	844
1884	310	215	520	171	90	331	80	72	1000	789
1885	290	195	480	156	90	340	100	89	960	781
1886	282	209	520	206	80	280	110	91	992	787
1887	240	180	480	162	60	240	100	90	880	672
1888	200	192	400	120	35	175	60	54	695	541
1889	180	173	350	97	60	240	70	56	660	567
1890	210	184	400	125	50	233	60	58	720	601
1891	205	178	595	235	40	215	75	72	915	701
1892	164	184	479	192	27	148	50	47	720	571

TABLE B. SAILING TRAWLER "THOMAS STRATTON."

YEAR.	PLAICE.		HADDOCK.		"PRIME."		"ROUGH."		TOTAL.	
	cwts.	£	cwts.	£	cwts.	£	cwts.	£	cwts.	£
1875	549	319	937	543	63	178	30	28	1579	1069
1876	601	318	894	471	50	133	31	32	1576	954
1877	422	224	573	310	80	232	17	16	1092	782
1878	239	141	403	188	62	182	27	26	731	538
1879	298	195	252	107	111	324	72	68	733	693
1880	249	151	228	64	79	221	46	44	602	480
1881	138	88	105	46	81	228	47	43	371	405
1882	411	283	741	277	87	250	95	89	1334	899
1883	274	234	648	320	123	345	90	85	1135	984
1884	260	155	530	180	100	360	95	93	985	789
1885	240	142	400	162	80	310	100	86	820	701
1886	220	182	500	200	65	211	90	83	875	677
1887	200	164	480	160	60	242	90	89	830	626
1888	180	172	360	108	45	225	65	59	650	565
1889	160	153	330	94	60	240	75	59	625	546
1890	200	172	450	150	50	231	70	69	770	623
1891	200	175	590	230	49	240	90	80	929	726
1892	126	134	374	140	28	160	29	27	557	460

TABLE C. SAILING TRAWLER "CLIMAX."

YEAR.	PLAICE.		HADDOCK.		"PRIME."		"ROUGH."		TOTAL.	
	cwts.	£	cwts.	£	cwts.	£	cwts.	£	cwts.	£
1875	506	317	1145	698	54	151	37	34	1742	1200
1876	565	361	993	513	53	150	36	34	1647	1058
1877	317	206	792	409	61	172	37	35	1207	822
1878	230	102	381	159	39	107	24	23	674	391
1879	292	156	859	327	71	199	37	33	1259	714
1880	344	219	373	177	49	137	41	39	807	573
1881	292	188	341	146	144	404	137	128	914	867
1882	420	300	870	314	100	280	92	86	1482	981
1883	347	243	675	249	131	368	68	54	1221	924
1884	320	225	620	201	130	366	70	54	1140	846
1885	290	198	510	172	110	390	80	58	990	818
1886	250	202	530	216	100	350	90	82	970	850
1887	225	168	480	160	80	320	80	75	865	723
1888	190	183	380	114	50	250	45	41	665	589
1889	190	176	350	98	70	249	60	54	670	577
1890	200	181	420	129	40	212	50	46	710	569
1891	200	174	590	233	55	252	70	64	915	723
1892	194	231	325	124	27	208	55	51	601	614

TABLE D. SAILING TRAWLER "NYANZA."

YEAR.	PLAICE.		HADDOCK.		"PRIME."		"ROUGH."		TOTAL.	
	cwts.	£	cwts.	£	cwts.	£	cwts.	£	cwts.	£
1875	557	341	941	514	56	160	27	26	1581	1041
1876	709	339	896	512	46	131	46	43	1697	1025
1877	511	222	717	422	66	186	12	11	1306	840
1878	299	156	747	327	98	275	41	39	1185	797
1879	340	185	583	214	164	436	57	54	1144	890
1880	291	157	493	212	47	177	33	31	864	577
1881	295	155	430	202	27	102	35	33	787	492
1882	403	212	770	298	46	172	87	83	1306	764
1883	456	256	734	312	43	163	63	59	1296	790
1884	410	220	430	182	65	182	70	55	975	639
1885	300	160	520	168	80	308	75	62	975	698
1886	250	200	490	193	65	209	60	57	865	659
1887	220	168	460	152	50	195	80	73	810	588
1888	210	196	350	102	40	201	60	55	660	555
1889	180	161	340	89	65	249	70	71	655	571
1890	210	185	592	231	50	231	80	77	932	725
1891	208	183	586	228	46	235	80	76	920	722
1892	189	202	568	235	33	208	64	60	854	706

TABLE E, *showing approximately the number of First Class* TRAWLING SMACKS *belonging to* (1) *the East Coast,* (2) *the South and West Coasts, and* (3) *the Entire Coasts of England and Wales and the Isle of Man.*

	Source of Data.	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
Scarborough.	‡	60	40	33	30	30	20	20	19	12	(?) 8
Hull .	. *	360	300	280	280	280	250	215	160	140	44
Grimsby	. I.R.	602	521	513	531	546	502	452	336	227	168
Yarmouth	. I.R.	380	500	501	465	422	446	360	378	314	289
Lowestoft	. *	180	203	206(?)	320	320	320	320	320	320	320
Ramsgate	. §	155	158	160	161	158	176	183	183	188	186
(1) **E. Coast:** total		1737	1722	1693	1787	1756	1714	1550	1396	1201	1015
Dover	. I.R.	16	16	16	16	16	16	15	15	15	18
Folkestone	. I.R.	—	—	—	—	—	1	2	3	2	2
Rye .	. Reg.	29	28	28	30	28	28	28	33	38	39
Newhaven	. Reg.	8	8	7	8	9	7	9	8	8	4
Brixham (Dartmouth)	. Reg.	244	244	245	252	248	243	244	252	260	264
Plymouth	. †	74	70	68	63	63	62	61	60	62	60
Tenby	. I.R.	21	19	19	24	23	23	23	23	23	23
Aberystwyth	I.R.	1	2	3	3	4	4	5	3	3	5
Carnarvon (Pwllheli)	. Reg.	11	12	12	10	11	11	10	10	11	10
Liverpool (Hoylake)	. Reg.	44	50	34	34	34	24	27	29	28	26
Fleetwood	. Reg.	65	67	66	59	58	53	51	51	46	44
Whitehaven	Reg.	13	13	14	13	13	15	11	11	10	10
Isle of Man	. Est.	20	20	20	20	20	20	20	20	20	20
(2) **S. & W. Coasts:** total owned .		546	549	532	532	527	507	506	518	526	525
East Coast visitors		40	60	40	40	25	25	25	30	30	35
S. & W. Coasts: total working		586	609	572	572	552	532	531	548	556	560
(3) **Entire Coasts:** total .	.	2323	2331	2265	2309	2318	2246	2091	1944	1757	1575

I.R. = Inspectors' Reports. Reg. = Register of first class fishing vessels *less* steam fishing vessels registered. Est. = Estimated from Register and Inspectors' Reports.

* Inspectors' Reports, except 1891 and 1892 (see pp. 37, 38).

† Inspectors' Reports, slightly modified for years 1889, 1890, 1894, 1895 (cf. *Jour. M.B.A.*, vol. i., O.S., p. 66).

‡ Inspectors' Reports, modified in the years 1894, 1895, and 1897.

§ Inspectors' Reports, except that the figure assigned for 1894 has been reduced by 10, in order to keep it within the limit of vessels registered at the port. The remaining figures approximately correspond with the Register.

TABLE F, *showing approximately the number of* (1) *Steam Vessels and* (2) *First Class Sailing Vessels engaged in* LINE FISHING *from the principal ports on the East Coast* (*estimated from the Inspectors' Reports*); *together with a reduction of the above to a uniform unit of catching power* ("*trawler equivalent*").

(1) **Steamers:**	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
N. Shields .	30	34	22	26	32	36	44	46	39	31
Hull . .	2	8	8	10	12	12	12	12	12	8
Grimsby . .	6	15	17	25	25	30	33	42	50	41
Total . .	38	57	47	61	69	78	89	100	101	80
"Smoothed".	**40**	**50**	**50**	**60**	**70**	**80**	**90**	**100**	**100**	**80**
Factors .	5	5·25	5·5	5·5	5·5	5·6	5·7	5·8	5·9	6
Trawler-equivs.	200	262	270	330	385	448	513	580	590	480
(2) **Sailers:**										
Staithes . .	12	5	9	9	9	9	7	5	5	4
Scarborough .	60	50	36	35	35	35	40	40 (?)	40 (?)	30 (?)
Filey . .	15	9	9	8	9	9	9	9	9	9
Bridlington .	7	18	14	14	14	13	13	13	11	11
Grimsby . .	138	104	101	124	135	114	99	89	50	20
Harwich . .	15 (?)	15 (?)	15 (?)	15	15	13	7	7	6	7
Total . .	247	201	184	205	217	193	175	163	121	81
"Smoothed"	**240**	**210**	**205**	**205**	**205**	**190**	**175**	**160**	**120**	**80**
Trawl.-equivs.($\frac{4}{5}$)	192	168	164	164	164	152	140	128	96	64
Add do. of Steam.	200	262	270	330	385	448	513	580	590	480
Total equivalents of all liners .	392	430	434	494	549	600	653	708	686	544

TABLE G, *showing the Mean Quarterly* TEMPERATURES *for the British Islands for the years* 1889 *to* 1898, *together with the Means for the period of thirty-three years,* 1866 *to* 1898 (*from the Summaries of the Weekly Weather Reports*).

	Jan.–March.	April–June.	July–Sept.	Oct.–Dec.
Mean, 1866–98	40·3	51·5	58·2	43·9
1889	39·7	52·5	57·0	44·2
1890	41·3	51·0	57·6	42·7
1891	39·2	50·6	57·3	43·6
1892	37·9	50·9	56·3	42·1
1893	**41·1**	**54·6**	**59·2**	**44·4**
1894	41·2	51·0	56·9	45·9
1895	35·2	52·2	59·1	43·8
1896	42·4	53·2	58·0	42·2
1897	40·4	51·2	58·1	45·9
1898	**41·9**	**51·5**	**59·4**	**47·5**

TABLE H, *showing approximately the total number of First Class Trawling Smacks, and of Steam Trawlers and Steam and Sailing Liners reduced to* SMACK-EQUIVALENTS, *for each year from* 1889 *to* 1898, *distinguishing the East Coast, the South and West Coasts combined, and the Entire Coasts of England and Wales and the Isle of Man.*

I. EAST COAST (BERWICK TO RAMSGATE).

YEAR	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
Steamers regd. .	249	291	409	458	514	565	606	680	748	900
Deduct liners, etc.	103	113	121	135	150	157	175	192	201	202
Steam trawlers	146	178	288	323	364	408	431	488	547	698
Factors .	5	5·25	5·5	5·5	5·5	5·6	6·3	7	7·7	8
Smack-equivs.	730	934	1584	1776	2002	2285	2715	3416	4212	5584
Smacks . .	1737	1722	1693	1787	1756	1714	1550	1396	1201	1015
Equivs. of liners	392	430	434	494	549	600	653	708	686	544
Total smack-units	2859	3086	3711	4057	4307	4599	4918	5620	6099	7143

II. SOUTH AND WEST COASTS (DEAL TO SOLWAY FIRTH).

Steamers regd. .	46	47	50	54	48	48	51	68	92	100
East Coast visitors	26	41	40	70	62	48	62	70	68	67
Total st. trawlers	72	88	90	124	110	96	113	138	160	167
Factors .	5	5·25	5·5	5·5	5·5	5·6	6·3	7	7·7	8
Smack-equivs.	360	462	495	682	605	538	712	966	1232	1336
Smacks (local)	546	549	532	532	527	507	506	518	526	525
Smacks (visitors)	40	60	40	40	25	25	25	30	30	35
Total smack-units	946	1071	1067	1254	1157	1070	1243	1514	1788	1896

III. ENTIRE COASTS (ENGLAND, WALES, AND I. OF MAN).

Steamers regd. .	295	338	459	512	562	613	657	748	840	1000
Deduct liners, etc.	103	113	121	135	150	157	175	192	201	202
Steam trawlers	192	225	338	377	412	456	482	556	639	798
Factors .	5	5·25	5·5	5·5	5·5	5·6	6·3	7	7·7	8
Smack-equivs.	960	1181	1859	2073	2266	2554	3037	3892	4920	6384
Smacks . .	2323	2331	2265	2309	2318	2246	2091	1944	1757	1575
Equivs. of liners	392	430	434	494	549	600	653	708	686	544
Total smack-units	3675	3942	4558	4876	5133	5400	5781	6544	7363	8503

Preliminary Experiments on the Rearing of Sea-Fish Larvæ.

By

Walter Garstang.

THE present paper contains an account of experiments made at the Plymouth Laboratory in the summer of 1899 with the object of determining the conditions necessary for the artificial rearing of sea-fish larvæ through the critical stages of their development. As is well known, the majority of the attempts which have hitherto been made in this direction have proved abortive, and such success as has been obtained has been limited to the survival of a very small proportion of the original stock of fry. There was therefore ample scope for new work upon the subject, especially for experiments based on comparative methods which should aim more particularly to elucidate the habits of fish larvæ under clearly contrasted conditions. In this way only did it appear possible to make further progress in our knowledge of the physiological peculiarities of the delicate fry and of the conditions which are essential to their healthy development in confinement. The successful issue of the present experiments is entirely attributable, I think, to the fact that they were not undertaken until practically undivided attention could be given to them, which enabled me to watch long and closely the habits of individual larvæ under different conditions, and under the guidance of these observations to modify and perfect the simple apparatus employed until the mortality became reduced to reasonable proportions.

The only records of successful experiments in the rearing of sea-fish larvæ are those of Dr. H. A. Meyer in 1878 with the Baltic herring, of Captain Dannevig in 1886 with the cod in Norway, and of Mr. Harald Dannevig in 1896 with the plaice at Dunbar.

Dr. Meyer* reared a number of larvæ of the Baltic winter herring from eggs which had been artificially fertilised on the Schlei River. The larvæ were confined in a large tub containing water from the Bay of Kiel. Half the water was changed daily, and was filtered before its introduction into the tub in order to remove all but the most minute organisms from the water. A considerable mortality among the larvæ took place after the tenth day, apparently from an insufficient supply of food of the right kind; but the beneficial effects which followed the subsequent introduction of unfiltered water (containing a richer supply of larger organisms) were so conspicuous that a number of the larvæ completed their metamorphosis and were reared to a length of 72 millimetres (nearly 3 inches), their age at this length being about five months. Unfortunately neither the number nor percentage of the survivors is mentioned.

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* *Biologische Beobachtungen bei künstlicher Aufzucht des Herings der Westlichen Ostsee.* Berlin, 1878. (Translated in *Report U.S. Fish Commission for* 1878, pp. 629–38.)

Captain Dannevig's* experiment was carried out on a greater scale. He placed about 500,000 young fry of the cod, which had been artificially hatched, into a large basin of sea-water attached to the Flödevigen hatchery on the south coast of Norway. The capacity of the basin was about 2,500 cubic metres (88,000 cubic feet), the greatest dimensions being:—length, 43 metres; breadth, 20 metres; depth, 5 metres (*i.e.* about 140 by 66 by 16 feet). During the first month the larvæ refused artificial food, and no plankton (minute floating life) was provided for them except such as was already present in the sea-water. They were observed to attack, kill, and eat each other in considerable numbers, but were still too small to attack the numerous crab larvæ which were also present in the water. From the second month onwards, however, they ate considerable quantities of finely-powdered mackerel, which was given them twice a day, and their rate of growth greatly increased. At the end of the fifth month they had attained an average length of 115 mm. (4½ inches), the largest caught being 157 mm. (6 inches) long. At the eighth month the number of survivors was estimated to amount to "several thousands." This famous and most important experiment served Captain Dannevig's purpose in demonstrating that fry artificially hatched have the power to live, grow, and develop when set more or less at liberty; but it is clear that, strictly speaking, the demonstration is limited to a small percentage† (not more than one or two per cent.) of the original stock of larvæ. By the following April, *i.e.* when about a year old, some of the survivors were about a foot in length.‡

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* *Report of the Codfish Hatchery at Flödevig, Norway, for* 1886. (Translated in *Bull. U.S. Fish Commission*, VII., 1887, pp. 113–19.)

† Mr. Harald Dannevig, in a reference to his father's experiments, states that "*most* of the young fishes survived the following winter" (*Fifteenth Report Scottish Fishery Board*, part iii. p. 176). Although I have not seen the original report, this would appear from the American translation to be a mistake.

‡ Ewart, *Fifth Report Scottish Fishery Board*, pp. 235, 244; McIntosh, *British Food Fishes*, p. 244; Cunningham, *British Marketable Fishes*, p. 287.

According to Professor Ewart,* Dannevig also set free a number of young herring in the same pond. Some completed their metamorphosis, but the greater number fell victims to the hungry cod.

Lastly, in 1896, Mr. Harald Dannevig,† at the Dunbar hatchery, succeeded in rearing a number of plaice through their complete metamorphosis, in a glass carboy holding ten gallons of sea-water. Twelve hundred larvæ were introduced, but the proportion of the survivors is not stated, except that the healthy larvæ, from which alone the survivors were derived, formed the minority from the beginning. The water was changed once or twice a day, and plankton from the harbour was added twice a day. The water in the carboy was subject to convection currents, caused by inequalities in the temperature of the water and that of the surrounding air. To the gentle movements of the water, due to this cause, Mr. Dannevig attaches much importance. The oldest stage described by Dannevig is that of an average specimen of the forty-fifth day, which had been on the bottom of the jar for several days, and measured 13·76 mm. ($\frac{7}{16}$ inch) in length, and 6·4 mm. ($\frac{1}{4}$ inch) in breadth.

On the other hand, the difficulties of the problem are clearly brought out in the numerous unsuccessful experiments described by Cunningham,‡ and by MM. Fabre-Domergue and Biètrix,§ as well as by the experiments known to have been made without result by other naturalists. Cunningham's experiments dealt chiefly with pelagic eggs; those of the French naturalists were based upon the demersal eggs of *Cottus*, but also included experiments with various kinds of pelagic eggs.

When the metamorphosis of a Teleostean larva has been accomplished, however, no further difficulty in rearing the young fish is experienced in most cases. This remark is particularly true of bottom fishes, such as flat fishes and gadoids, which have been repeatedly reared from the earliest adolescent stages even up to maturity, both in the Plymouth Laboratory and elsewhere; and it has been shown that the rate of growth is principally dependent upon the temperature and the food-supply to which the young fishes are subjected—conditions which can easily be controlled. There can, indeed, be no doubt that the possibilities of marine fish culture would be great and various, if we could bridge the gap in our knowledge as to the proper methods of treating the fry during the transformation from the larval to the adolescent stages. Promising as are the results of the experiments described above, it is clear that our knowledge of the conditions of larval life and development is quite inadequate so long as we can only ensure the survival of a minute percentage of the fry in our rearing experiments.

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* "On the Artificial Hatching and Rearing of Sea Fish." *Fifth Report Scottish Fishery Board*, 1886, p. 235.

† "On the Rearing of the Larval and Post-larval Stages of the Plaice and other Flat Fishes," *loc. cit.*, pp. 175–192; also *Sixteenth Report*, pp. 223-4.

‡ "Experiments on the Rearing of Fish Larvæ in 1894." *Journal of the Marine Biol. Assoc.*, iii., 1894, p. 206.

§ "Recherches biologiques applicables à la Pisciculture Maritime." *Ann. Sci. Nat.* (viii.), t. 4, 1897, pp. 151–220.

The species employed in my experiments was the "Butterfly Blenny" (*Blennius ocellaris*), which, at Plymouth, usually lays its eggs in the empty shells of whelks (*Buccinum*), in moderately deep water offshore (15 to 20 fathoms), whence relays of its eggs were easily obtainable with the dredge during the past summer (1899).

Although many offshore types of fish doubtless differ from it as to the special conditions requisite for their development, yet the observations made upon the development of this species cannot be without value in regard to the rearing of other offshore larvæ in captivity.

The eggs of the Butterfly Blenny have been described by Cunningham,* and the structure of the larva soon after hatching by Holt.† The larva at this stage is already well organised: the mouth is formed, the eyes pigmented, the yolk relatively small in quantity and moderately protuberant, and the pectoral fins well developed. On the other hand, the vertical fin membrane is still in the primitive undivided condition, the lower jaw is immovable, and the permanent skeleton has not yet made its appearance. The larva thus approximates in type to the early larva of *Cottus* and other demersal forms, and is more highly organised than the early larvæ derived from pelagic eggs such as those of flat fishes and gadoids, which indeed do not, strictly speaking, merit the term "larvæ," since they are merely embryos released from their shells, and incapable of capturing food for themselves. These so-called "pelagic larvæ" (which are not more peculiarly pelagic than the larvæ arising from demersal eggs) might well be distinguished from true larvæ, as "embryonic larvæ" or "embryo larvæ." The larva of the Butterfly Blenny, at the time of hatching, corresponds in its grade of organisation with a plaice larva five or six days old.

Holt assigns a length of 6·30 mm. to the larva of the Butterfly Blenny when twelve to twenty-four hours old. This dimension considerably exceeds that of all the specimens which I have measured at a corresponding age, as will be seen from the following records of the size of four specimens, in millimetres :—

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* *Journ. M. B. A.*, i. 1891, p. 36, fig. 35.

† *Ann. du Musée d'Hist. Nat. de Marseille, Zool.*, v., 1899, p. 45, pl. 6, fig. 63; *Journ. M. B. A.*, v. p. 122.

	3 to 4 hours old.				20 to 24 hours.
Total length	4·6	4·5	4·6	...	4·6
Length from anterior extremity to posterior surface of yolk . .	1·18	1·15	1·17	...	1·15
Ditto to posterior surface of rectum .	1·62	1·55	1·58	...	1·60

These larvæ were hatched on August 4th from a batch of eggs dredged the same day. They were killed and preserved in weak formalin, and measured on August 5th. In view of the slight nature of the differences in my measurements of separate individuals, it is difficult to account for the discrepancy * between our observations, especially as I find the same length in early larvæ of another batch hatched on June 16th. The difference can scarcely be attributed to contraction of my specimens in formalin, since in the oldest of the above-mentioned larvæ the longest rays of the pectoral fin were seen to fall short of the anus by 0·15 mm., whereas in Holt's specimen they extended 0·12 mm. behind the anus. Moreover, in larvæ which had died a natural death and become opaque, the pectoral fin-rays were often noticed to stretch beyond the anus, as in Holt's specimen, but this was never the case with fresh or living larvæ derived from the August batch referred to above. Several larvæ measured fresh on the third and fourth days had a length of exactly 5 mm.

Holt remarks upon the delicacy of the larvæ and their susceptibilities to slight injuries, an observation which in the early stages of these experiments I had frequent opportunities of confirming. The water in the jars was at first renewed by siphoning off half the water and pouring slowly from a broad-lipped jug, at first directly and subsequently through a funnel; but the currents produced by the first method, and the impact of the bubbles of air driven down the funnel, were excessive and caused considerable injury. This method was subsequently replaced by allowing the water to enter the jars in a slow stream from a siphon provided with a stopcock. Even the capture of a larva by means of a dipping tube was sufficient to stun and kill it.

If the larvæ are kept in a "plunger-jar," the diameter of the plunger-plate in relation to the diameter of the jar is an important item, and any excess which produces eddies of any violence during the movements of the plunger is certain to prove fatal. At first my larvæ were placed in tall bell-shaped hatching jars having a height of 16 inches and an internal diameter of 8 inches. The plunger-plate was circular and had a diameter of 4½ inches. The plunger made three complete strokes in exactly two minutes, *i.e.* one plunge, including both down and up stroke, in 40 seconds. The downward stroke was gentle and occupied 15 or 16 seconds, followed by a pause of 5 seconds, but the upward stroke was smarter and lasted only 8 seconds. The apparatus was then quiescent for about 12 seconds before the next stroke began. The eddies in the water caused by the rapid movements of the plunger were so extensive that the larvæ were frequently caught in the streams and whirled around, and, although these involuntary gyrations did not appear at the time to have any greater effect than to temporarily arrest the activity of the larvæ, I was soon convinced that the mortality which the larvæ exhibited in these first experiments was largely attributable to the incessant harrying to which the movements of the plunger subjected them. When the original plunger-plate was replaced by a much smaller one of 2½ inches diameter, not only were the water-movements greatly moderated, but the condition of the larvæ generally improved.

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* Mr. Holt informs me by letter that the total length assigned to the larva in his papers is a mistake due to an error of transcription, and should have been 5·30 mm. After a re-examination of his specimens, however, I find the total length to be the same as in mine, viz. 4·6 mm. (varying between 4·55 and 4·65). I have verified the accuracy of my micrometer, so that no difference between our larvæ need be assumed.

The powers of the larvæ in stemming a constant current, however, were considerable. When the water in a jar was being changed, the waste water was at first siphoned off through a glass tube provided with a thistle-funnel (covered with fine gauze) at one end and a stopcock at the other. It was remarkable to notice the success with which both Copepods and young Blenny larvæ could for some time compete with the current setting through the funnel, even when the tap was fully open. As soon as they felt themselves within the influence of the current they would give vigorous darts in the opposite direction, the fishes generally escaping, the Copepods often. But the weaker larvæ which did not dart away smartly enough were drawn up against the gauze. The weakest would remain there, scarcely offering resistance; but the majority, as soon as they touched the tight gauze surface, would give a most powerful leap, and dart clear away from funnel and current alike into relatively still water. Many showed no serious objection to the current itself, and allowed themselves to be drifted up against the gauze; but the moment they felt this obstacle they leaped away as just described. The Copepods, as a rule, were unable to jerk themselves beyond the influence of the current except momentarily, and thus maintained a prolonged contest in the form of incessant darts or leaps from the neighbourhood of the sieve, to be repeated as fast as the current beat them back upon it.

EXPERIMENTS A, B, AND C.

The experiments which I made last year fall into four groups (see table p. 76). The first set (A, B, and C) was designed to test the effect of confining the young larvæ in jars of water fitted with Browne's stirring* apparatus known as the "plunger." Three jars of the same size and shape were employed, and were fitted with plungers of equal size worked from the same motor. All the jars were filled with water from the offing beyond the Breakwater, but in one (A) the water had been standing in the Laboratory for some weeks and had previously contained Echinoderm larvæ, while in the other two the water was fresh from the sea. One of the latter jars (C) was immersed in a tank of circulating water downstairs in order to maintain a fairly constant temperature; the other (B), together with the jar of stale water, was placed in front of a window facing west, and was fully exposed to the changes of temperature in the air of the building. The same number of larvæ (twenty-five) was placed in each two-gallon jar (August 4th). The larvæ in the stale water were all dead or moribund in three days. Half of the larvæ in each of the remaining jars had died within a week, and all were dead on the tenth day, except one which survived until the fourteenth. The rapid mortality in experiment A was obviously attributable to some impurity in the stale water; that in B and C was traceable partly to the excessive movements of the plunger, as described above, partly to insufficient food in the first week, and partly to the over-accumulation of dead plankton in the limited quantity of water.

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* See *Journ. M. B. A.*, v., 1898, p. 176.

Table showing, for each experiment, the initial number of larvæ, and the number surviving on every fourth day.

Experiment begun	Aug. 4th.			Aug. 10th.	Aug. 17th.			Aug. 23rd.		
(=date of hatching).	A	B	C	D	F	G	H	J	K	L
Age: Newly hatched...	25	25	25	19	10	10	?	10	10	10
4 days old	0	17	18	11	9	7§	6	6	4	7
8 ,,	—	3	3	11	9	4§	6	all moribund.		
12 ,,	—	1	0	9*	9	4	4			
16 ,,	—	0	—	9	8	4	4			
20 ,,	—	—	—	2‡	6†	...	3†			
24 ,,	—	—	—	2	5	...	3			
28 ,,	—	—	—	2	5	...	3			
32 ,,	—	—	—	2	4	...	3			
36 ,,	—	—	—	2	4	...	3			
40 ,,	—	—	—	2	3	...	3			
44 ,,	—	—	—	2	2	...	3			
48 ,,	—	—	—	2	—	...	—			
52 ,,	—	—	—	1	—	...	—			

Merged together
in jar H on Oct. 1st.

* Deaths caused by the water becoming impure and turbid.

† Deaths caused by mechanical accidents.

‡ Deaths caused chiefly by transference of larvæ to a tank of circulating water in which, by an accident, they were exposed to the attacks of rapacious Copepods.

§ Deaths probably caused by mechanical accidents due to a defect in the jar subsequently discovered (August 26th), and rectified same day.

These factors so completely dominated the conditions of the experiments that no conclusions could be drawn from the slight differences between the jars at constant and variable temperature, although the heat at the time was so great and the fluctuations in the temperature of the exposed jars were so considerable that further experiments were all carried on in immersed vessels.

The water in the three jars was left unchanged for the first three days of the experiments, but half of the water in each jar was changed daily after this date. To avoid any ill effects from subjecting the larvæ to rapid changes of temperature, the new supplies of "outside water" in these and all other experiments were always raised to the same temperature as the water in the jars before being added. The temperature of the water in these and the remaining experiments described below was daily observed and recorded at about the same hour in the forenoon, 10 to 11.30 a.m., and oftener in certain experiments.

The food supplied was always plankton, which was obtained with fine silk nets beyond the Breakwater as a rule. But no food was given in A, B, and C until the fifth day of the experiments, when the larvæ were already four days old. This was a radical error. The larvæ must, to some extent, have been starved, since on this day I found from an examination of the corpses that the yolk had already been absorbed in some, and on the following day was entirely absorbed in eight out of the ten corpses examined. After this date plankton was added daily, and in the remaining experiments was provided from the beginning of each experiment.

The size of the plungers was reduced on the seventh day in B, and on the eighth day in C.

Faeces and plankton débris were removed by a dipping tube at first, and subsequently by a siphon. This was an essential item in each day's operations. If neglected, the larvæ at once began to suffer.

Experiment D.

A second experiment (D) was begun a week after the preceding (August 10th), in order to subject a slightly smaller initial number of larvæ (nineteen) to similar conditions, modified, however, by the adoption of a smaller plunger from the second day of the experiment, and by closer attention from the beginning of the experiment to the feeding of the larvæ, and the cleansing and change of the water in the jar. These modifications resulted in a marked reduction of the mortality, especially after the third day, and in a healthier appearance of the larvæ. More than one-third of the larvæ died in the first three days, leaving eleven alive and active on the fourth day of the experiment. These numbers remained unchanged until the eighth day, when one or two larvæ were observed to be somewhat feeble, in consequence of the turbidity of the water, and on the ninth day only nine larvæ survived. These, however, after careful cleansing of the jar, were all flourishing. They were growing in bulk, and displayed the greatest activity in their search for food. Their numbers remained unchanged for another week, at the end of which time (the sixteenth day) it was clear that the conditions of the experiment were perfectly suitable for their development, so long as the water could be kept clean and abundance of food could be provided. During the course of the experiment, from one-half to two-thirds of the water had been changed every day, and fresh plankton added daily with rare exceptions. But irregularities in the quantity and condition of the available plankton were unavoidable, causing occasionally a slight deficiency in the amount provided, and at other times an over-accumulation of dead Copepods, etc., in the jar, and consequent soiling of the water. The larvæ at this time had grown considerably, being about 7·5 mm. in length, and nearly 2·0 mm. in maximum depth, as taken through the hinder part of the eye. The larval fin membrane was still continuous, but the notochord was turned up posteriorly, the tail fin properly formed, the hypural plates and caudal fin-rays established, the fin-rays in the dorsal and ventral fins in process of formation, and the rudiments of the pelvic fins present. There was thus no doubt that the larvæ were growing and developing properly, and were already undergoing the critical stages of their metamorphosis.

On the other hand, the increasing difficulty of keeping their jar clean in consequence of the large amount of food they required, and the death of a larva on the seventeenth day, induced me to remove some of the larvæ from this jar, and see the effect of placing them in a circulation of the ordinary tank water, which would at any rate solve the difficulty of keeping the water clean.

Three of the larvæ were therefore transferred on the eighteenth day to a portable slate tank, with a glass front, holding four gallons of water, and placed in the main laboratory on the south side of the central tanks. The bottom was covered with gravel, and a circulation was set up with every precaution to avoid loss or injury of the larvæ from the current established. On the following day all three were alive and active, whereas another death had occurred in the original plunger-jar. The four survivors were thereupon cautiously transferred to the portable tank, and a liberal supply of fine plankton was provided. Late in the afternoon only three or four out of the seven were swimming about, the others being on the gravel at the bottom. They appeared to be incommoded by the brighter light of their new situation, so a sheet of green glass was placed in front of the tank. No obvious effect on the fishes was noticeable, but the tank was appreciably darkened. Next day five of the larvæ had completely disappeared, and no trace of their remains could be discovered in the gravel or elsewhere. The circulation was all right, and escape by the siphon overflow (a broad funnel imbedded deeply in the gravel) was quite impossible. On further examination it became practically certain that the larvæ had been devoured by Harpacticid Copepods (almost exclusively *Idya furcata*) which had entered their tank through the siphon from the supply tank above. These Copepods were present in the fishes' tank in myriads—on the slate sides, on the glass, in the gravel, and freely swimming; and I subsequently found, from an examination of the supply tanks, that they abounded in many of these tanks, especially on the glass fronts, from which, in this case, they had clearly been drawn through the siphon supplying the portable tank. The siphon had inadvertently been displaced, so that its mouth rested against the glass front of the supply tank.

The rapacity of these Copepods was easily tested upon dead or moribund larvæ derived from other experiments. The *Idya* appears to fix itself to its prey by the second antennæ in front, and the second maxillipeds behind. The mandibles, or neighbouring appendages (the precise organs were not determined), then make a rapid series of bites from before backwards, accompanied by an incessant scratching movement carried on by the setæ of the mouth parts. The fin membrane of a larva was quickly gnawed away in semicircular patches, like the holes on the edge of a leaf by caterpillars. To test the rate of dismemberment, three entire corpses of Blenny larvæ were placed at 4 p.m. in a small dish containing sixty-eight Copepods, all of which, as determined after the experiment, were *Idya furcata*. Next morning the corpses had entirely disappeared except a fragment of one larva, and the faintest possible traces on the sites of the other two.

In order to see whether the Copepods would also attack living prey, I placed four healthy young *Gobius minutus*, each about one inch long, in the tank. On examining one, which was near the glass front, some time afterwards with a lens, I could see two of the Copepods on the base of the tail fin, busily engaged eating the fin membrane. The Goby appeared to feel no serious discomfort from their proceedings, though it occasionally made restless movements as though slightly irritated. Its movements, which were repeated three or four times while I watched, did not dislodge the Copepods. Next morning one of the Gobies was dead, and had been browsed upon by one at least of its companions, as well as by the Copepods. Its death, however, seemed attributable to the latter.

On the other hand, the Copepods appeared to prefer dead to living prey. A moribund Blenny larva was placed in a watch-glass of sea-water with a number of the Copepods, and kept under observation under the microscope for twenty minutes. The larva was still capable of spasmodic darts. The Copepods occasionally settled on the larva, but usually left it at once, even when the latter made no signs of objection to their presence. If they remained, and began to feed, the larva would shake them off by wriggling away, though sometimes with difficulty if the Copepod was tenacious. Twelve Copepods visited the larva during the time. Of these, seven left at once, three very soon, and two after being shaken off by the larva. At the end of twenty minutes the moribund larva was removed, and a corpse offered to the same Copepods. In the same time nine Copepods visited the corpse. Of these only three left at once, while the other six remained to feed, some for five minutes, but the majority for the remainder of the experiment. The moribund larva was now weaker; the heart was beating, but the respiratory movements had ceased. It could no longer shake off the Copepods, and these remained to feed precisely as on the corpse.

The above experiments indicate that these carnivorous Copepods, especially *Idya furcata*, prefer dead prey, but do not hesitate to attack living fishes or larvæ on occasions. Although even Blenny larvæ could probably free themselves of these pests under ordinary circumstances, the extraordinary accumulation of the Copepods in my rearing tank appears to have subjected the larvæ to such incessant attacks from them that they were unable to cope with them, and finally gave way, especially as the second lot of larvæ appears to have been rendered temporarily torpid from the beginning by the change from the plunger-jar to the tank—a condition which would reduce their ability to drive off the pests.

I made one further experiment which may provide a useful means of preventing the accumulation of these Copepods in aquaria. A small Wrasse (*Ctenolabrus rupestris*), 2 inches long, was introduced into the tank when the Copepods were literally teeming within it. Next morning the Wrasse was very lively, and the Copepods were exceedingly scarce. On watching further, I saw the Wrasse busily engaged picking them off the slate walls one by one with unvarying exactitude. Its stomach on dissection was found to be filled with the Copepods.

The result of this instructive accident in my second rearing experiment was that the two larvæ which still survived in the slate tank were again transferred to a plunger-jar as before; and in this they continued to thrive for another month without further incidents calling for notice. They completed their metamorphosis, and one survived to become a sturdy little fish an inch in length, with the entire organisation and habits of the adult, even to the extent of making a house for itself out of a small *Trochus* shell. It was preserved with the survivors from other experiments in the second week of November, at an age of three months (thirteen weeks). Its companion had died a month earlier (October 1st) of a complaint which frequently recurred among the larger fry, and which at this time I did not properly understand. As will be described below, I eventually satisfied myself that this ailment (the principal symptoms of which were a kind of flatulence and an inability to remain below the surface of the water) was a result of the excessive feeding in which the fry frequently indulged after the daily supply of plankton.

EXPERIMENTS F, G, AND H.

These experiments were begun with a new batch of larvæ a week later than the preceding experiment (August 17th) with the object of determining whether the initial death-rate in the earlier experiments might not be prevented by placing a still smaller number of larvæ in the rearing jars—a plan which would render the larvæ less liable to suffer from the occasional impurity caused by an excess of dead plankton in the limited quantity of water, which could not conveniently be changed more than once a day as a rule. All these experiments, it should be remembered, were begun in the height of a hot summer (August, 1899) when the temperature of the aquarium water stood constantly in the forenoon at about 19°·0 C. (=more than 65° Fahr.), and varied only between 18°·8 and 19°·2 at that time on different days.

Two jars (F and G) were at first taken, of the same kind as before, and were immersed side by side, under precisely similar conditions, in the same tank of water. The same plunger-plates (diameter 2½ inches) were also employed, and were worked by the same motor and therefore at the same rate. The only difference between the two experiments that was intentionally introduced was in the character of the water supplied, as I was anxious to compare the mortality of the larvæ when kept in offshore and harbour water respectively. One jar, therefore (F), was kept constantly supplied with inshore water pumped up from immediately below the Laboratory. It was taken from one of the large Laboratory settling reservoirs before being circulated through the aquaria, and was therefore pure unused harbour water. The other jar (G) was supplied with offshore water brought in carboys rom beyond the Breakwater as before. The remaining conditions of the experiment would have been practically identical had it not been for a defect in the latter jar, which was not discovered until nine days after the experiment commenced. The rearing jars are each perforated at the apex for the insertion of a supply pipe (for hatching purposes), but for my purposes these holes were closed by the insertion of corks, the inner surfaces of which were covered with a layer of hard paraffin wax to prevent the entrance of impurities from the corks in the inverted position in which they were employed. On the fourth day of the experiment (August 20th) three larvæ in G had completely disappeared, and one had again disappeared three days later (August 23rd) without leaving any trace—a most unusual occurrence. On the 26th, when siphoning off the sediment from the bottom of this jar, I saw a larva sucked into a gap beneath the layer of paraffin covering the cork at the bottom, and was only able to release it with difficulty. The cork had clearly not been driven in quite flush with the outer neck of the jar before the experiment, and had thus been forced inwards to a slight extent after being placed upright in the inverted position, thus detaching the paraffin layer from the inner face of the glass. The crevice so formed was just large enough to allow a larva to enter. This jar was the only one in which such a detachment of the paraffin had taken place, and the defect accounts in all probability for the frequent deaths in G as compared with F in the early stages, the larvæ having got in, and either injured themselves or failed to emerge. After the defect was remedied no further deaths occurred in the jar except one on the following day, which probably resulted from the accident which I had observed.

Thus exact comparison between the two experiments is scarcely possible, though the healthy development of the larvæ in F fortunately renders such comparison unnecessary.

Ten newly hatched larvæ from the same batch of eggs were placed in each of the two jars. They were fed with plankton from the beginning, and half of the water, or even more, according to circumstances, was changed daily in each jar. A summary of the results is shown in the table (p. 76).

The advantage of giving the larvæ a more plentiful supply of water and food from the beginning was clearly shown by the trifling death-rate at the beginning of the experiment, and by the healthy and vigorous condition of the larvæ. In F one corpse was removed on the second day of the experiment, a death which was almost certainly of an accidental character, but from this day no deaths occurred until the end of a fortnight. The larvæ were active and healthy during the whole of this period until the last few days, when two, which were not growing so rapidly as the others, showed signs of inactivity and died during the following week. Another was lost on the seventeenth day (September 3rd) by being drawn up the siphon during the cleaning of the jar. From this date I was unable to watch the experiments from day to day, owing to absences caused by work at sea and my attendance at the Dover meeting of the British Association. As far as possible, however, the same routine was continued in the treatment of the fry in my absence, and two survived the forty-fourth day (September 30th) when they, with the survivors from D and H, were merged together into the jar devoted to this last-mentioned experiment, the conditions of which appeared to be more suitable than plunger-jars for the later stages of development.

During the course of this experiment the larvæ throve splendidly during the first few weeks, up to a length of about 10 mm., and completed all the essential structural changes in their metamorphosis, the permanent fins having been formed and the skeleton established. They were always very lively, and darted about after Copepods with great agility, displaying much pertinacity and considerable acrobatic powers in their efforts to secure their prey.

Their methods of hunting were always alike, and were so eminently characteristic as to merit a brief description. Upon noticing some fancied morsel, the larva would immediately become transformed with excitement, and, keeping its face constantly towards the object, would commence a series of evolutions, the first purpose of which was to investigate the nature of the prey, and the second to circumvent the latter's escape. Wheeling round through the quadrant of a circle by a series of strokes of the tail, aided by synchronous movements of the pectoral fins, the larva, if satisfied with the result of this preliminary survey, would leap smartly round from side to side of the chosen morsel until by a well-directed forward dart the quarry was seized or frightened away. If the attack were successful, the larva would swim quietly about again; but if unsuccessful, it would swiftly pursue and repeat the same process until success rewarded its efforts or the Copepod finally escaped. The pectoral fins were ceaselessly employed in these movements, whether from side to side, up and down, or even backwards. Under these circumstances Mr. Holt's suggestion* that the large size of the pectorals in these larvæ may be of merely ancestral significance appears unnecessary. It is true, as my colleague remarks, that these fins are not very effective organs of locomotion, so far as pace alone is concerned; but it is impossible to spend any time in watching these larvæ hunting for food without forming the conviction that the fins are particularly adapted to enable their possessors to cope with the peculiar dodging movements of the Copepods they pursue, which resemble to some extent the well-known tricks of the so-called hovering flies of our gardens and hedge-rows (fam. *Syrphidæ*).

Resuming my narrative, however, the fry, in later stages, after the third week, did not as a rule appear to do so well in this jar as those in jar H, to be described below. They continued to grow rapidly, but individuals from time to time had strange fits of torpidity, and at a stage when the larvæ in H were already settling on the bottom, those in F showed a marked preference for the surface, which they refused to leave. They were obviously not quite healthy; and, although I adopted a different interpretation later on (see p. 86) in connection with similar phenomena in jar H, I attributed the unhealthiness of the larvæ at the time to the unsuitability of the conditions in the plunger-jar, since after the larvæ were transferred to the stagnant water in H they assumed habits similar to those of their companions almost immediately (next day).

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* *Journ. M. B. A.*, v., 1898, p. 123.

It is possible, though unlikely, that the ill health of the later larvæ in F was due to a deterioration in the reservoir water, which was changed a few weeks after the commencement of the experiment. In August the harbour water was doubtless of an exceptionally pure character, in consequence of the long dry summer, but the rains of September must have subsequently affected its salinity and quality in the neighbourhood of the Laboratory, as they undoubtedly drove away the Red Mullet which had previously been lurking about the mouth of the Cattewater in exceptional abundance.

Thus in spite of the low mortality in this experiment during the first few weeks, which points to the suitability of the harbour water at that time, I should hesitate to conclude that the harbour water would be usually suitable for the development of this fish in other years or at other seasons of the year, when the salinity is lowered by the greater quantity of fresh water coming down the Tamar, Tavy, and Plym.

Experiment G requires little to be said of it in consequence of the initial defects in the jar already alluded to. On the nineteenth day (September 4th), prior to my Channel cruise, I preserved the four survivors in this experiment in order to have some material for studying the anatomical details of the progress made in development. The larvæ varied in length at this stage between 6·8 mm. and 8·0 mm. The maximum depth through the hinder part of the eye was 2·0 mm. in the largest specimen. The notochord was turned up posteriorly in the largest, but scarcely bent at all in the smaller specimens. Two hypural bony plates were developed in the largest, but were quite insignificant in the smallest larva. Delicate caudal fin-rays in fan-like tufts were conspicuous in all, and formed a protruding ventral lobe to the fin in the smaller specimens.

A noteworthy, though not conspicuous feature of the larva up to this stage, and even for another week beyond it, is the permanently gaping mouth. The larvæ do not close their jaws until they are a full month old, when the teeth begin to appear.

Experiment H was started on August 22nd, in order to see the effect of transferring larvæ four or five days old from a plunger-jar to a jar of stagnant water, devoid of a plunger, and aërated by means of green algæ exposed to direct sunlight immediately in front of a south window. The jar was broader than the rearing jars, and of different shape, having a flat bottom and cylindrical sides, and terminating above in a shoulder and a neck about 3 inches in diameter. It contained about 3 gallons when full, but was not filled during the first few weeks beyond about two-thirds or three-quarters of its total height. It was immersed to a little below the same height in a tank of circulating water in the full blaze of the midday and afternoon sun. The current in the outer tank was not strong enough to keep the temperature in the jar constant, but served to moderate it. The following series of temperatures give an idea of the range of temperature to which the larvæ were exposed:—

	Aug. 25.		Aug. 26.	Aug. 27.	Sep. 2.	Sep. 7.
	10 a.m.	4 p.m.	3 p.m.	Noon.	2 p.m.	? hour.
Temp. of water in tank . .	19°·9	21°·0	21°·6	19°·7	18°·7	19°·2
,, ,, jar (top) .	20°·3	23°·0	24°·1	19°·8	19°·2	20°·0
,, ,, ,, (bottom)	19°·8	21°·3	21°·6	19°·7	18°·8	19°·2

As shown by the figures, the uppermost layer of water in the jar was generally warmer than the rest during the daytime, since the outer jacket of circulating water was not high enough to surround it; and the amount of the excess depended on the sunshine, amounting to 2½° C. on hot afternoons (*e.g.* August 26th) or of a mere fraction of a degree on cloudy days (August 27th, September 2nd). The bottom temperature amounted to 22°·0 at 4 p.m. on August 23rd, but rarely exceeded 21°·0 after the first few days.

A small tuft of *Ectocarpus* was placed at the bottom of the jar under a small glass funnel as a means of aërating and purifying the water. During sunshine the small bubbles of oxygen emitted by the plant escaped into the surrounding water in a continuous stream through the narrow aperture of the funnel; and in a very short time the bottom and sides of the jar became covered with a perfect jungle of the same alga from the fixation and development of the spores liberated by the original tuft, which, with the funnel, was then removed.

Into this jar, on August 22nd, were placed six larvæ derived from the same batch of eggs as those in experiments F and G, but they were already from four to five days old at the time of their introduction. Previous to this they had been kept in a plunger-jar (E) under the same external conditions as F and G. They had not, however, received much attention. The six larvæ were the survivors of ten or eleven which had been isolated on the 18th (from twelve to twenty-four hours after hatching), and had received no change of water and only one supply of plankton in the interval. The feebler larvæ may therefore be supposed to have been already weeded out.

In the new jar (H) the larvæ were subjected to the same attention as those in F and G; that is, the water was partially changed every day, a daily supply of plankton was provided, and débris and faeces were removed every morning by means of a siphon.

Although no deaths occurred during the first four days, the larvæ did not thrive so well at the beginning as in the plunger-jars. Several of them from the beginning showed signs of torpidity and lay about on the bottom in a listless condition, possibly in consequence of the greater heat to which they were subjected, possibly also from the lack of motion in the water. Two deaths soon resulted. The remainder, however, became increasingly active, and two in particular began to grow at an unusually rapid rate, soon outstripping their companions. The improvement coincided with a cessation of the excessive heat towards the end of August. On the 30th of August they were all lively, and one was particularly large, being to all appearances as far advanced as the two survivors in D at the same date, although a full week younger. The tail fin was formed, as well as the early skeleton. My diary for the 30th states: "All these larvæ are very healthy and are incessantly swimming. They seem to be in no need of a plunger at this stage." Except the two cases recorded above, no deaths whatever occurred in this jar up to the end of October, when the larvæ were seventy-four days old. The reduction in the number between the sixteenth and twentieth days shown in the table (p 76) was caused by one being accidentally lost during the changing of the water on September 5th. Occasionally one or other of the largest fry exhibited temporary fits of ill health. The fish would lie at the top of the water, immediately beneath the surface film, spasmodically wriggling and often curling up as if in pain. The abdomen in such cases was always distended with food and gas, and the whole body was lighter than the water, so that the fish could not do otherwise than float at the top. I could diagnose the complaint in no other way than as a kind of flatulence or dyspepsia resulting from over-feeding. I fear this explanation may seem to others to savour of anthropomorphism, but I can only point to the fact that before I arrived at this explanation several deaths occurred in jars D and F from similar causes, from inability to treat the cases properly, whereas, after I became convinced of it, I repeatedly brought these ailing fishes back to health again by reducing their supplies of food. It should be borne in mind that fish larvæ in the sea are never surrounded by such quantities of food in small compass as these fry confined to the space of a two or three gallon jar in my experiments, especially as no attempt was made to spread the supplies of food over a long portion of the day. When the tow-nettings arrived, the bottles were always allowed to stand for a few minutes in a convenient position near the jars, so that the Copepods might concentrate themselves near the source of light. They were then poured directly into the jars, or siphoned in, according to the degree of their concentration. Thus the fishes were surrounded by a superabundance of food during a portion of the day, and as their instincts were obviously to catch a Copepod whenever the chance presented itself, it is scarcely surprising that they should have occasionally suffered from an excessive diet. For rearing work on a larger scale I therefore believe that one of the many principles that will need attention will be to avoid the possibility of the larvæ enjoying these periodic surfeits by securing a more uniform supply of food for the fry than was attempted in these preliminary experiments.

On October 1st, when the larvæ in H were forty-five days old, my diary states that the fry were all healthy and that they were already giving up their pelagic habits so as to rest for considerable intervals on the bottom of the jar, from which they would rise, however, from time to time in search of food or from mere love of movement.

On this day, as already related, I transferred the three survivors from experiments D and F to the same jar, in which they lived together without loss for another period of five weeks, *i.e.* to the end of the first week in November, although the smallest was removed on the 1st of this month for preservation and anatomical examination.

It measured 15 mm. in length, and the length of the pectoral fin was 4·9 mm. The dorsal fin possessed twenty-six rays (12 + 14); the anal, eighteen; and the caudal eighteen rays. The mandible, which protruded in front of the upper jaw, possessed four teeth on each side of a median gap. Teeth were also present in the upper jaw, but were not counted. The supraorbital tentacles were invisible to the naked eye, but could be detected with a lens as a pair of short unpigmented papillæ situated vertically above the most anterior margin of the pupil of the eye. The eyes were set far forward, their anterior margins coinciding with the frontal margin of the head. The pupil alone was blue or black, the iris being golden. The black chromatophores on the head formed a continuous sheet and were not arranged in radii. The colour of the body (both living and preserved in formalin) was dark brown, almost black, over the whole head region (top and sides), over the anterior half of the abdomen, and over the pectoral and pelvic fins. The entire caudal region was colourless and transparent excepting a single line of chromatophores along the base of the anal fin. A line of internal pigment ran along the spinal column as far back as the fifth ray of the posterior dorsal fin.

The other Blennies, five in number, appeared to vary at this time from about 16 mm. to 22 mm. in length. The actual dimensions a fortnight later are given below.

Up to this time (the end of October) the fry had been regularly fed with plankton, but at the end of this period the available supplies of large Copepods became much reduced, partly from the impoverishment of the plankton which normally takes place in autumn, and partly from bad weather in November, which interfered with the work of collection. The fry would no longer attack the smaller Copepods (*Oithona, Paracalanus, Acartia,* etc.), and *Calanus* was not obtainable. No Crabs, Prawns, or Shrimps could be found in berry, except isolated specimens carrying new-laid eggs, which the fish refused to touch. I therefore tried feeding them with bits of chopped Prawn. They would occasionally seize morsels as they fell through the water, but not after the fragments had settled on the bottom. On the 6th of November one of the largest Blennies died, almost certainly of starvation, owing to the difficulty of providing suitable food. On the 9th I introduced a number of small Crustacea (Mysidæ, Cumacea, and Amphipods) obtained by working a tow-net immediately above the sandy bottom in Cawsand Bay. A more successful diet was provided on the following day by working a cheese-cloth net over the Zostera bed in the same locality, which brought in a number of small Terebellid and Nereid worms with a few Crustacea. The results were excellent, for the wriggling movements of the worms after they were thrown into the jar at once attracted the attention of the fishes, which snapped them up with avidity. The Nereids appeared to prick the fishes and to be relatively unpalatable, but the Terebellids were eaten with great satisfaction. The largest of the surviving Blennies, which had been ailing during the past week, and had refused all food, now began to recover, and shared the new food with the others. I saw it capture quite a large Amphipod, which, after a little difficulty, it succeeded in swallowing. Only one further incident demands notice. On the 8th of November, having observed that for several days past a piece of Ulva frequently had one of the fishes underneath it, I introduced a number of small empty Gastropod shells, chiefly *Trochus*, into the jar. One of the little Blennies at once tucked himself inside one, resting on his pelvic fins, with his head outwards near the orifice, in all respects like the adult fish. A little later there were two fish inhabiting shells. The adoption of this habit at so early a period was not only a sign that the fry had completely departed from the pelagic habits of the larval stages, but is interesting from a general point of view. It shows that the conchicolous habit of the adult fish is not a mere nesting device for the protection of the eggs, but is adopted at probably all stages of growth for concealment and protection.

The object of the experiments being now achieved, I decided to preserve the little fishes at this stage (three months old) in order to have material for a detailed account of their development.

The young fishes, even in the preserved condition, are attractive little objects. Compared with young salmon or trout fry of the same length, they are seen to be much more robust, partly owing to the shortness and distension of the abdominal region. In the young trout the ventral surface of the body from mouth to tail forms a practically straight line, while the dorsal surface is evenly arched; in the young Blenny the dorsal surface is straight, and the ventral is arched. The greatest depth of the body in the young trout lies nearly midway between the mouth and the base of the tail; in the Blenny it occurs immediately behind the head.

The skin is darkly pigmented with black chromatophores over the front half of the body, but is still colourless and transparent in the posterior part of the caudal postanal region. Behind the head the dark brown pigment is distinctly arranged in a series of vertical bars. A broad bar covers the front half of the abdominal region, and extends over the anterior part of the first dorsal fin. After a narrow interval, a narrower and more clearly defined bar extends across the hindmost region of the abdomen at the boundary between it and the caudal region. Corresponding with this bar, though slightly anterior to it, is the black ocellus of the first dorsal fin, which extends between the sixth and eighth fin-rays, and is well defined in the larger specimens, though still undeveloped in the two smallest. From the ocellus to the ventral margin of the body the bar follows a backwardly directed curve, which becomes almost vertical below the region of the lateral line. The alternating pigmented and unpigmented stripes are of about equal width, equivalent to about the width of two adjacent interspaces between the dorsal fin-rays. In the caudal (postanal) region, only one of these bars is completely formed, but an additional one is distinctly indicated in the largest specimens. The brown pigmentation of the trunk thus extends backwards as growth proceeds, not as a continuous sheet, but in the form of vertical stripes.

Yellow and red chromatophores are also present, but are not easily located.

The pupil of the eye is black, without any suggestion of blue. The iris has a golden basis, obscured to a large extent by black chromatophores.

The pectoral and pelvic fins are covered with black chromatophores. An interesting series of changes in the colour of the pectoral fins took place during growth. In the newly hatched larva these organs were black, as figured by Holt; but about a week or ten days afterwards, if development had proceeded normally (as in my experiments D, F, G, and H), the black chromatophores were kept constantly contracted, the resulting colour being a bright greenish yellow. This condition was retained until the end of the third week, when the black chromatophores began to be partially relaxed, producing a distinct green-finned stage, which gradually passed into the ultimate dark-finned condition, the change being more or less synchronous with the abandonment of pelagic habits.

The supraorbital tentacles are larger than in the specimen 15 mm. long described above, and are pigmented. They can be seen in the larger specimens without the aid of a lens.

The lower jaw does not protrude beyond the upper in any of these specimens. In other structural details the fry do not materially differ from the smaller specimen already described. The eyes in all specimens are set equally far forward.

The dimensions of the body and number of fin-rays in all five fishes are given in the subjoined table. To complete the series I have added the figures already given for the specimen killed on November 1st:—

	Maximum		Number of Fin-rays.		
Age.	Length.	Depth.	Dorsal.	Anal.	Caudal.
13 to 14 weeks	25·5 mm.	6·6 mm.	11 + 14	17	20
	24·5 ,,	6·6 ,,	11 + 14	17	20
	24·5 ,,	6·4 ,,	11 + 14	17	19
	21·5 ,,	6·3 ,,	11 + 14	17	17
	19 ,,	5·0 ,,	11 + 14	17	20
11 weeks	15 ,,	4·0 ,,	12 + 14	18	18

In explanation of the figures I should add that the length of body includes the caudal fin; but the depth has been determined from the base of the dorsal fin to the ventral surface, the exact line being drawn across the base of the pectoral fins. The number of fin-rays was in each case determined with the microscope.

It will be noticed that the number of dorsal and anal fin-rays is remarkably constant, since it is identical in five out of six specimens. The abnormality which occurs in the smallest fish is apparently not a variation due to difference of size, but a true individual variation affecting the upper and lower fin alike. The caudal fin is subject to greater variation, partly due to growth.

On comparing these numbers with those assigned by Holt to the later larva figured in his paper,* a considerable difference is noticeable, since Holt's larva, having a body length of 18 mm., possessed twenty-seven dorsal (12 + 15) and nineteen anal rays, thus exceeding by one dorsal and one anal ray the numbers exhibited by the abnormal specimen in my series. The identification of Holt's larva* with *Blennius ocellaris* was admittedly tentative; but in view of the data now available, I am inclined to think that this identification should be abandoned, and that the larva should be provisionally referred to *B. trigloïdes.*

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* *Ann. Mus. Hist. Nat. Marseille*, 1899, p. 46, pl. 6, fig 64.

In support of this suggestion I would point principally to the difference between my specimens and Holt's description and figure in regard to the position and colouration of the eye, the pigmentation of the head, and the possession of preorbital and supraorbital tentacles.

The eye in Holt's figure is set much further back than in any of my larvæ; there is no trace in the latter of the radial arrangement of facial pigment which is so prominent a feature in my colleague's specimen; and the preorbital tentacle figured by Holt has no counterpart in my larvæ. This tentacle is not referred to in the text of Holt's description, but can only represent the tentacle which in several species of Blenny is situated at the anterior orifice of the nares. According to Moreau the nasal tentacle is found both in *B. inæqualis* and *B. trigloïdes,* but is sometimes wanting in *B. ocellaris.* On the other hand, a supraorbital tentacle is found in *B. inæqualis* and *B. ocellaris,* but not in *B. trigloïdes.* In Holt's larva the supraorbital tentacle appears to have been wanting, but is distinctly developed in my larvæ, even at a smaller size. Consequently it is probable that Holt's larva should be referred to *B. trigloïdes.*

In general features, however, Holt's figure gives a fairly good idea of the proportions of the body in larvæ of *B. ocellaris* at the same stage.†

EXPERIMENTS J, K, AND L.

These experiments were begun with a new batch of larvæ on August 23rd, after I had already gained considerable experience as to their habits, in order to determine whether agitation of the water was necessary or not for their successful development during the period immediately after hatching, care being taken that the water should be thoroughly oxygenated, and that ample supplies of food should be present in the water from the beginning.

Shallow rectangular glass aquaria were chosen for the experiment, since they presented a large surface for aëration of the water. They were immersed in the circulating water of the aquarium tanks, in order to preserve a fairly constant temperature; and were filled with the same water as was proving so successful with experiment F. No plunging apparatus was set up, and no convection currents were possible under the conditions of the experiment, the water being absolutely stagnant. Ten active larvæ hatched the same day were placed in each jar.

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* I have since had an opportunity of examining this specimen, which is far more slender and of less robust appearance than my larvæ at the same stage. It should certainly be assigned to a different species.

† My friend and pupil, Mr. Arthur Darbishire, of Oxford, is kindly preparing some figures illustrating the development of *B. ocellaris* with a view to publication.

Jar J was larger than the other two, and measured 18 inches long by 12 inches wide and 6 inches deep. This was immersed side by side with jars D and F in one of the table tanks of the aquarium.

Jars K and L were identical in shape and size, and measured 12 by 8 by 4 inches. They were immersed in the same tank as jar H in front of a south window.

One-quarter of the water was changed each day and fine plankton was added each morning, as in the early days of experiments F and G.

The early results of the experiments are shown in the table (p. 76). Two of the losses recorded (one in J, and one in L) resulted from accidents in changing the water, but from the second day of the experiment it was obvious that the larvæ were doing badly. A few swam about a little in the early days, more particularly in J, but the vast majority were very listless and inactive, making no efforts to feed, and lying passively on the bottom of the jars or at the very surface of the water immediately below the surface film. Their movements were limited to occasional spasmodic jerks, contrasting markedly not only with the movements of the larvæ in the plunger-jars D, F, and G, at a corresponding stage, but also with their own movements in the plunger-jar in which they were hatched, previously to their transference to the stagnant water. On the fifth day, when they were four days old, their numbers were reduced to six, four, and seven respectively; and all, except one or two in J, were exceedingly torpid and several in L were on the point of death. The experiments were continued a few days longer with no favourable change in the condition of the larvæ and an increasing number of deaths; but, as the results were already conclusive, I soon afterwards abandoned the experiments as not worthy of further attention.

The behaviour of the larvæ was precisely similar to that described with such careful detail by Fabre-Domergue and Biétrix in their admirable experiments upon *Cottus* and other forms, the principal symptom of which was the progressive anæmia and "etiolation" to which the larvæ in all their experiments fell victims. These naturalists at first* attributed these results to the noxious influence of the water in confinement, the precise nature of which was undetermined; but in a later note† they account for the result as more probably due to the failure to provide the larvæ with the food most suitable to them at the particular stage of growth.

I quite agree with the French naturalists, as well as with Mr. Harald Dannevig (*loc. cit.*), as to the necessity of supplying the larvæ with suitable food before the complete absorption of the yolk; but, in view of the precautions taken in my experiments, I can adopt no other explanation of the debility of the larvæ in experiments J, K, and L than that it was directly attributable to the absolute stagnancy of the water. Gentle movements of the water appear to be indispensable to the healthy development of fish-larvæ in the earliest stages after hatching; and I believe the physiological explanation of this necessity is to be sought in the stimulus to exercise and movement which the larvæ derive from the play of the currents. I am strengthened in this opinion by the successful results attained by Mr. Harald Dannevig in his experiments on the rearing of plaice larvæ, since he attached considerable importance in his experiments to the movements of the water brought about by convection currents. I am, however, strongly inclined to believe that a far greater percentage of larvæ would have survived in Dannevig's experiments if he had placed a much smaller number of larvæ in the ten-gallon jar he employed, and if he had amplified the currents by some mechanical contrivance in the first week or fortnight of development.

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* *Ann. Sci. Nat.*, viii., 1897, pp. 212–17.

† *Role de la Vésicule Vitelline dans la Nutrition larvaire des Poissons marins.* Comptes Rendus dés Séances de la Société de Biologie, 30th Avril, 1898.

CONCLUSIONS.

From the experiments detailed in the preceding pages it appears reasonable to conclude that the conditions which are most important for the healthy development of sea-fish larvæ, and to the survival of a high percentage of fry through the critical stages of the metamorphosis, are the following:—

(1) A liberal supply of pure water;
(2) Mechanical, but moderate, agitation of the water until the larvæ have become thoroughly active and accustomed to catch the food provided them;
(3) Provision of suitable food prior to the absorption of the yolk; and
(4) A fairly constant, but not excessive, supply of food each day, which should be introduced in frequent small doses, rather than in single concentrated supplies.

Reviewing the evidence, I am inclined to think that the water problem can best be solved in large experiments by maintaining a constant slow current through the rearing tanks, with plungers or other stirring apparatus in addition, so long as necessary. The former would tend to keep the water pure, the latter would give the larvæ a healthy start in the important matters of exercise and general activity. The precise method by which the food should be administered would depend largely on the species to be reared, since different larvæ are now known to have well-marked preferences for different articles of food.

Notes on the Rearing of Echinoid Larvæ.

By

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THE problem of successfully rearing the larvæ of Echinoidea until they had completed their metamorphosis, has been solved by several naturalists. Agassiz* was able, for three weeks, to keep plutei alive which he had fished from the sea, at the end of which time they sank to the bottom and became young echini. Bury† was able also to rear a few of the plutei of one of the Neapolitan species through the whole of their larval life, and finally Théel‡ has published an account of how he obtained all stages in the development of *Echinocyamus pusillus* from the result of artificial fertilisation.

During the months of May and June in both 1898 and 1899, I was occupied with a similar, though not identical problem. I wished to obtain sufficient material of all the stages of development of *Echinus esculentus* to enable me to make an exhaustive investigation of the formation of all the organs of the adult *Echinus*. For this purpose it was not sufficient to be able to rear one or two specimens through the metamorphosis; the question was to be able to obtain a considerable number of late and metamorphosing stages. This end was finally attained in July, 1899, twenty-four young echini and a large number of plutei, with an advanced rudiment of the echinus within them, were obtained.

Reviewing the history of two seasons' experiments, it seems possible to arrive at some idea of the conditions for the healthy life of these larvæ, and for the sake of future investigators these are outlined here.

The greatest number of experiments were made with *Echinus*

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* *Revision of the Echini*, L. AGASSIZ.

† According to a statement made to the author in 1894.

‡ "The Development of *Echinocyamus pusillus*," by H. THÉEL. *Proceedings of the Royal Society of Sweden*, Upsala, 1892.

esculentus, but for the sake of comparison, cultures of the larvæ of *Echinus miliaris* were also prepared.

The first condition for a healthy experiment is that only *full-sized* and *perfectly ripe* individuals of both sexes should be used for fertilisation. It is generally possible to get a few eggs capable of fertilisation from unripe individuals, but the resulting plutei are feeble, and soon die.

The fertilisation is best performed in a large square glass dish; a *small quantity* only of spermatozoa must be added to the clean sea-water with which the dish is filled. The ova are added in sufficient quantity to make a *single layer* over the bottom. A piece of bolting-silk of medium mesh will permit the ova to pass, but will keep back pieces of ovary, and to a large extent *unripe ova.*

The laboratory at Plymouth is provided with bolting-cloth of mesh exactly suitable to the eggs of *E. esculentus.* The unripe eggs appear to be surrounded by a thick, glassy membrane (entirely distinct from the membrane formed after fertilisation), which prevents their passing through the meshes of the silk.

After fertilisation, the water full of spermatozoa must not be allowed to stand more than twenty minutes before it is decanted off, and during the first twenty-four hours the water covering the eggs should be frequently changed.

Next in importance to the proper choice of individuals for the experiment is the selection of a proper source whence the sea-water is to be obtained. Water obtained close inshore is perfectly useless. The plutei will live for at most a week in it. In Plymouth, water must be brought from outside the Breakwater, and only this water must be employed for both fertilisation and the subsequent culture.

At the end of twenty-four to thirty hours, all the eggs which are developing normally will have reached the blastula stage, and have risen to the surface. They must then be decanted off into culture jars. The jars which I used at this stage in the experiments were of a deep bell-shape, and of a capacity of two gallons. Each was fitted with a Browne plunger. This invaluable apparatus has already been described elsewhere. It is sufficient here to notice that by means of it the water in the jars is kept in constant though gentle agitation, and the formation of a surface film of dust, bacteria, etc., effectually prevented.

The jars must be carefully guarded from direct sunlight, which soon proves fatal to the larvæ. They must be covered in as much as is consistent with the free motion of the plunger, and the water ought to be changed to the extent of one-third of its bulk every day. This is effected by temporarily stopping the action of the plunger, when the healthy larvæ will come to the top. The bottom water can then be siphoned off. It is advisable to have a small amount of a filamentous alga, such as *Ectocarpus*, floating in the water. Ulva, and other leaf-like forms, are more apt to decay, and then foul the water.

After the lapse of about eight to ten days, it will usually be seen that in one or two of the jars, development is proceeding normally, whereas in the others, symptoms of unhealthiness have appeared. The healthy larvæ are then transferred to larger culture jars, in which they complete the remainder of their development. The jars used for this purpose by me had a capacity of ten gallons, and each was fitted with a large plunger. Not more than 250 larvæ should be placed in each jar, and as before, the water should be changed to the extent of one-third of its bulk daily.

It may seem to many that the course of proceedings which I have sketched out is a very roundabout one. Why, it may be asked, should not 250 blastulæ be transferred directly from the dish in which fertilisation is effected to the larger jar? The answer is, that this course has been tried and it failed. In a word, it is not possible for the experimenter to discriminate between larvæ which have vigour enough to complete their development and those which will soon die, until the second week of their existence. We must, in the first instance, allow natural selection to weed out the weaker. In this connection a curious fact may be mentioned. A very successful result was obtained from a culture of larvæ proceeding from a fertilisation carried out very badly. The eggs were piled on one another, several layers deep, and the water remained full of spermatozoa all night. As a result, only about 10 per cent. or less of the eggs became blastulæ. But those which survived showed remarkable hardiness, and from them young echini were obtained.

Echinus esculentus and *Echinus miliaris* are decidedly different in colour, size, and general appearance, and it is not therefore surprising to learn that their larvæ are different in every period of existence, as has been detailed in a paper in the *Quarterly Journal of Microscopical Science* (vol. xlii., 1899, p. 335). Here it need only be mentioned that the larva of *E. miliaris* has only four ciliated epaulettes, and that the young echinus at metamorphosis has one pair of tube feet in each interradius, in addition to the azygous tentacle. The pluteus of *E. esculentus* on the other hand has six ciliated epaulettes, which eventually coalesce in order to form two circular bands of cilia, and the young echinus has at first only the azygous tentacle in each interradius.

The necessity for such frequent changes of sea-water seems to arise rather from lack of food than from lack of oxygen, and it is more urgent in some years than in others, according to variations in the amount of vegetable plankton. In 1898 it did not seem so necessary, and in that year there were great quantities of *Halosphaera* in the water. I did not realise until late in 1899 that such a quantity of water should be added each day; had I done so earlier, my success might have been even greater than it was. The fact was brought to my attention by observing that plutei went on living in an apparently healthy manner, but that the rudiment of the echinus within them either failed to increase in size, or was actually resorbed.

It appears to me likely that the difficulty experienced in rearing many marine larvæ is largely that of finding food; for there appears to be no reason why they should require more oxygen per day than do the yolky eggs of other species in which development is direct, and goes on with great rapidity.

In conclusion, I have to express my gratitude to my friends Mr. E. J. Allen, the Director of the Station, and Mr. E. T. Browne, of University College, London, for much assistance and advice.

Zoological Laboratory, McGill University,
Montreal, *October* 9, 1899.

On *Maclovia iricolor* (Montagu).

By

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It is a pity that there should be any doubt as to the legitimacy of the generic and specific names of one of the longest Chaetopoda inhabiting Plymouth Sound, and it seems worth while to devote a special note to its synonymy and identification.

[*Names marked with an asterisk are synonyms.*]

*1. *Nereis iricolor*, Montagu, 1802. Description of several marine animals found on the South Coast of Devonshire. Tr. Linn. Soc., London, VII., Dec., 1802, p. 82.

Montagu found his specimen coiled under a stone among the rocks at Milton. It was the largest specimen of the genus [s.l.] hitherto recorded in British seas, measuring, when extended, about 3 feet in length, with the thickness of a raven's quill. When placed in fresh water it contracted to 1 foot in length, with the thickness of a goose-quill.

*2. *Lumbrineris gigantea*, Quatrefages, 1865. Hist. des Annelés, vol. i. p. 360. Hab. Bréhat; individuals in life measuring upwards of 60 cm.

*3. *Lumbrineris tricolor*, Johnston, 1865. A Catalogue of the British non-parasitical worms, London, p. 142. Hab. South Devon. " One specimen in the Museum Collection is 11 inches in length, and as thick as a large quill."

The parapodia are figured upside down. Johnson mentions " two dark spots obscurely marked, which may be eyes," at the posterior border of the cephalic lobe.

*4. *Arabella tricolor* (Johnst.). Ehlers, 1868. Die Borstenwürmer, pp. 399 and 405.

5. *Notocirrus scoticus*, M'Intosh, 1869 [see also under par. 7]. On the Structure of the British Nemerteans, and some new British Annelids. Tr. R. Soc., Edinb., XXV., p. 417. Points out that at least three species of Lumbrinereidae had been previously recorded in British seas, viz. *Lysidice ninetta* (Aud. Edw.), *Lumbriconereis tricolor* (Mont.), and *Lumbriconereis latreillii* (Aud. Edw.). "The two latter have probably been confounded with the *L. fragilis* of Müller, a species abounding on our northern and southern coasts." *N. scoticus* was taken in 6–9 fathoms in Lochmaddy, and subsequently in several parts of the Hebridean Seas. Body moniliform, much slenderer than *L. fragilis*; head acutely conical, with two eyes; parapodia ligulate; setae uniform.

*6. *Maclovia gigantea* (Qfg.), Grube, 1871. Vorlage einer *Lumbriconereis gigantea* (Qfg.), Jahresber. Schlesisch. Ges. 1871, Breslau, 1872, p. 58. Also Mittheilungen über St. Malo und Roscoff. Abh. Schlesisch. Ges. 1869–1872, Breslau, 1872, p. 86.

Specimen taken at St. Malo 1½ feet long; Grube saw only two eyes.

7. *Notocirrus tricolor* (Johnst.), Ehlers, 1874. Beiträge zur Kenntniss der Verticalverbreitung der Borstenwürmer im Meere. Zeitschr. wiss. Zool. XXV., 1875, p. 55, Taf. III. f. 33. Hab. off Galway, in 15–20 fathoms.

This is said to be the *N. scoticus* of M'Intosh [see under par. 5], which Ehlers erroneously identified with Johnston's *Lumbrineris tricolor*. It is described as having an ovate prostomium with two eye-spots; body submoniliform; maxillae I. unequal and without a large terminal claw. The character of the jaws resembles that described and figured by MARION and BOBRETZKY [Étude des Annélides du Golfe de Marseille. Ann. Sci. nat. (6) II., 1875, p. 15, Pl. I. f. 2] for *Notocirrus geniculatus*, Clpd., and proves conclusively that *N. scoticus* is quite distinct from our species.

*8. *Lumbriconereis iricolor* (Mont.), Grube, 1878. Fortsetzung der Mittheilungen über die Familie Eunicea. II^{te} Abth. Lumbriconereidea Schmarda. Jahresber. Schlesisch. Ges. 1878, Breslau, 1879, p. 87.

Grube here expresses his well-founded suspicion that the specific name "tricolor," given by Johnston, was due to a clerical error in copying a label in Leach's collection. He adds that both Montagu's and Johnston's descriptions indicate that the worm belongs to the genus *Arabella*, and is probably *A. quadristriata*, Gr.

*9. *Notocirrus tricolor* (Johnst.), M'Intosh, 1885. Annelida Polychaeta. Chall. Rep. XII., p. 236. M'Intosh here refers repeatedly to Johnston's species under the above name in continuation of Ehlers's mistaken identification [see above, par. 7].

*10. *Maclovia gigantea* (Qfg.), Saint-Joseph, 1888. Les Annélides Polychètes des côtes de Dinard. Ann. Sci. nat. (7), V., p. 30, Pl. IX. f. 92–95.

Maclovia is here regarded as a sub-genus of *Arabella*, characterised by the presence of five pairs of superior jaw-pieces and tripartite sustentacular apparatus. There are four eyes in the head in a transverse row.

The following will serve as a brief diagnosis of our worm :—

Corpus lumbriconereiforme, long. usque ad 600 mm.; lat. c. 5 mm.

Prostomium sub-ovate, oculis 4 transversa serie.

Segmenta buccalia bina, fere similia.

Pharetrae setarum in lingulas postero-inferiores carneas productae.

Cirrus dorsalis rudimentaris, fasciculo acicularum (5-7) haud emergentium praeditus.

Setae flavae, fere similes, acuminatae, plus minusve limbatae, geniculatae, saepe crenatae, paucae (c. 12).

Aciculae flavae, plures (6–7).

Segmentum anale lobis brevibus 4.

Maxillae I. inaequales (sinistra paullo major) unciformes, basi serrata dentibus c. 10; II. inaequales, dextra fere duplo longior dentibus 12–14, sinistra dentibus 6–7; V. hamuli singuli.

Radices maxillarum (sustentacular apparatus) 3.

Laminae ventrales nigrae edentatae.

The importance of the identification of the above species lies in the fact that it cohabits with a true *Lumbriconereis*, which bears a striking superficial resemblance to the *Maclovia*, but does not attain to the length of the latter. The two forms have often masqueraded under a common denomination.

The *Lumbriconereis* is probably co-specific with *L. latreilli* (Aud. Edw.) and may possess a length of about 6 inches.

It must be left to the future to decide upon the respective merits of *L. latreilli* and *L. fragilis*.

LONDON, *May 19th*, 1900.

International Conference for the Exploration of the Sea, Stockholm, 1899.

On the invitation of the Swedish Government an International Conference met at Stockholm, in June, 1899, for the purpose of formulating a scheme for a combined investigation of the Northern Atlantic, the North Sea, and the Baltic in the interests of the sea-fisheries.

The delegates appointed to represent the different countries who took part in the Conference were as follows:—

GERMANY.—Prof. F. Heincke, Prof. V. Hensen, Dr. H. Herwig, Prof. O. Krümmel.

DENMARK.—Captain C. F. Drechsel, Dr. M. Knudsen, Prof. C. G. J. Petersen.

GREAT BRITAIN AND IRELAND.—Mr. W. Archer, Prof. D'Arcy W. Thompson, Sir John Murray.

NORWAY.—Dr. J. Hjort, M. K. Lehmkuhl, Prof. F. Nansen.

HOLLAND.—Prof. P. P. C. Hoek.

RUSSIA.—Prof. O. von Grimm.

SWEDEN.—Prof. P. T. Cleve, M. G. Ekman, Dr. N. R. Lundberg, Prof. O. Pettersson, Dr. F. Trybom, Prof. A. R. Åkerman.

The scheme recommended by the Conference was embodied in a series of formal resolutions, which were passed unanimously by all the delegates.

The following are these resolutions:—

Considering that a rational exploitation of the sea should rest as far as possible on scientific inquiry, and considering that international co-operation is the best way of arriving at satisfactory results in this direction, especially if in the execution of the investigations it be kept constantly in view that their primary object is to promote and improve the fisheries through international agreements, this International Conference resolves to recommend to the states concerned the following scheme of investigations which should be carried out for a period of at least five years.

Programme for the Hydrographical and Biological work in the Northern parts of the Atlantic Ocean, the North Sea, the Baltic and adjoining Seas.

A.

THE HYDROGRAPHICAL WORK.

I.

The hydrographical researches shall have for their object: the distinction of the different water-strata, according to their geographical distribution, their depths, their temperature, salinity, gas-contents, plankton, and currents, in order to find the fundamental principles not only for the determination of the external conditions of the useful marine animals, but also for weather-forecasts for extended periods in the interests of agriculture.

II.

As the hydrographical conditions are subject to seasonal changes, and as these strongly influence the distribution and life-conditions of useful marine animals and the state of the weather and other general meteorological conditions, it is desirable that the observations should be made so far as possible simultaneously in the four typical months, February, May, August, and November, at definite points along the same determined lines.

III.

The observations referred to in II. would consist of:—

(*a*) Observations of temperature, humidity and pressure of the air every two hours; self-registering instruments for interpolation, and Assmann's aspirator should be used.

Opportunities should be afforded to the meteorological offices to make on board the ships physical observations on the higher levels of the atmosphere by means of kites.

The other meteorological observations are to be carried out according to the methods adopted by the meteorological offices of the nations represented.

The observations, meteorological as well as hydrographical, made on board the special steamers at the time of the survey in the typical months, are to be immediately worked out under the supervision of the central bureau (see C) for publication in a bulletin, wherein the conditions of the sea and the atmosphere are to be represented by tables and synoptical charts in co-operation with the meteorological institutes of the nations represented.

(*b*) The temperature of the surface water shall be taken every two hours, or, when necessary, more frequently. It is desirable that self-registering apparatus should be used for interpolation.

Observations on the vertical distribution of the temperature are to be taken at the points mentioned in II., and should be taken regularly at intervals of 0, 5, 10, 15, 20, 30, 40, 50, 75, 100, 150, 200, 250, 300, 400 metres and so on; but all *critical* parts of the curve must be determined by extra-readings.

The bottom-temperature is to be investigated with all possible care.

(*c*) At every point and from every depth where the temperature is observed, a sample of water shall be collected for the determination of its salinity and density.

By *salinity* is to be understood the total weight in grammes of the solid matter dissolved in 1,000 grammes of water.

By *density* is to be understood the weight in grammes* of one cubic centimetre of water of the temperature *in situ* t°, *i.e.* the specific gravity *in situ* referred to pure water of $+4^\circ$C $\left(= S\frac{t^\circ}{4^\circ}\right)$.

For orientation, preliminary determination of the salinity should be made on board ship with expedient instruments, but the exact determination of the salinity and density of all samples shall take place in a laboratory for scientific work.

(*d*) At certain depths of the points mentioned in II., and elsewhere on the surface, water samples should be collected for analysis of the gas-constituents (oxygen, nitrogen, and carbonic acid).

IV.

For measurement of depth the *unit* to be adopted is the metre, together with which the depth may be also recorded in English fathoms.

Geographical points are to be referred to the longitude of Greenwich, and horizontal distances are to be expressed in sea-miles (=1,852 metres).

Thermometers to be used for the determination of the surface-temperature may be either centigrade or Fahrenheit, but for publication all numbers are to be reduced to centigrade.

In the centigrade thermometers the distance between two degree-marks should be at least 5 mm. and the degree divided at least in two parts, the Fahrenheit thermometer to be divided in a corresponding manner.

The use of Pettersson's insulated water-bottle is recommended for moderate depths, and the thermometers used for this apparatus should have a space at least 10 mm. between the marks of one degree, and the degree should be divided in ten parts.

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* Units of weight are here used instead of mass-units.

For greater depths of the ocean Negretti-Zambra's or other thermometers of a similar type should be used.

The glass to be used for the thermometers as well as the thermometers should be tested and approved by the central bureau (see C, *a*).

For the determination of salinity and density, either chemical or physical methods may be adopted, provided that the salinity can be determined with an accuracy of 0,05 in a thousand parts (and the density up to 0,00004).

The determination of these constants can be founded either upon chemical analysis of the halogen by weighing or titration, or upon physical determination of the specific gravity by means of hydrostatical balance pycnometers and hydrometers, provided that measures be taken to exclude disturbances arising from thermal effects, capillarity, viscosity, etc.

The chemical analysis shall be controlled by physical methods, and the physical determinations by chemical analysis in the following manner:—

From every collection of samples examined at least three shall be selected and sent to the central bureau. *Standard samples* shall be sent in return.*

The *specific gravity* is to be represented in the tables by the formula $S\left(\frac{0^\circ}{4^\circ}\right)$.

V.

Samples for gas analysis are to be collected each time in a pair of sterilised vacuum tubes.

It is desirable that the existing tables of absorption of nitrogen and oxygen should be revised.

VI.

Qualitative plankton-observations should be made every six hours by pumping through a silk net (Nr. 18) for the space of fifteen minutes, and at the same time a sample of water (III. *c*) should be taken.

At the points mentioned in II. samples for quantitative analysis are to be collected according to the method of Prof. Hensen at different depths depending on the hydrographical circumstances.

Petersen's modification of Hensen's net is recommended.

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* By *standard* water shall be understood samples of filtered sea-water, the physical and chemical properties of which are known with all possible accuracy by analysis, and statements of which are sent to the different laboratories, together with samples.

In respect to halogen the ordinary water-samples have to be compared with the standard water by analytical methods.

Observations on transparency and colour of the water should be made at the points mentioned in II.

Opportunities should be afforded to bacteriological institutions to carry out investigations in the ocean.

VII.

Observations on currents and tides should be carried out as frequently as the circumstances allow.

The currents should be examined, when possible, by direct current-meters and by surface and intermediate floats and by bottom-rollers.

The ship should be anchored occasionally in order to make frequent observations during a complete period of tide.

VIII.

It is desirable that a chart should be prepared of the bottom of the seas examined, showing the nature of the sea-bottom.

The description of the deposits is to be carried out on a definite plan, to be afterwards settled. (See Appendix III.)

IX.

The normal observations are to be carried out along the lines provisionally drawn on the annexed chart, where *R* denotes the Russian, *F* the Finnish, *S* the Swedish, *G* the German, *Da* the Danish, *Du* the Dutch, *N* the Norwegian, and *B* the British lines.

The special points are to be decided by the respective nations, and when once chosen the subsequent observations are to be repeated at the same points.

The particular instructions for the stations will be given by the respective nations, and the communications as to the extent and the nature of the observations shall take place through the central bureau. (See C, *a* and *e*.)

X.

It is desirable, in carrying out these investigations, to make use of regular liners, light-ships, etc., and coast stations for the purpose of taking temperature-observations and collecting samples of sea-water and plankton.

These observations are to be taken not only in the typical months but also during the intervening periods.

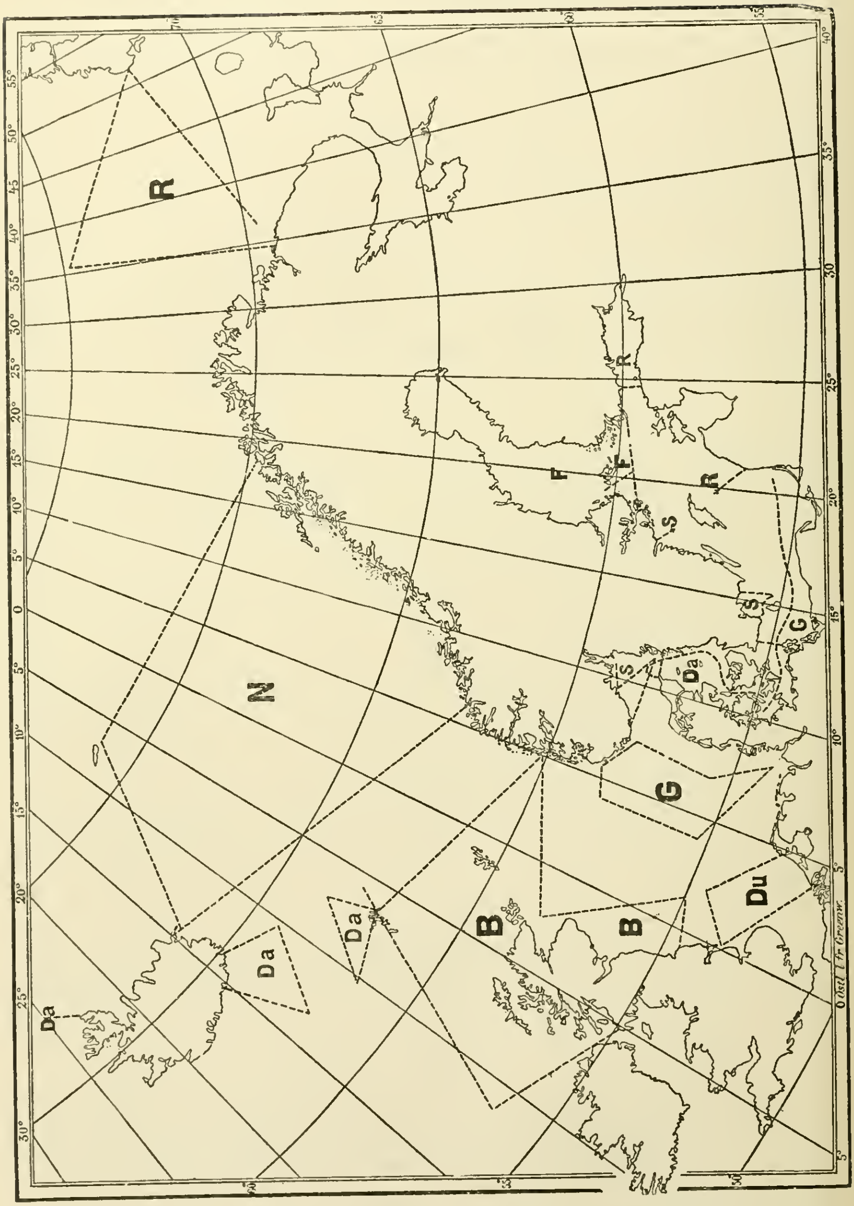
R
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CHART SHOWING THE LINES OF OBSERVATION RECOMMENDED BY THE STOCKHOLM FISHERIES CONFERENCE.

B.

THE BIOLOGICAL WORK.

I.

(*a*) Determination of the topographical and bathymetrical distribution of eggs and larvæ of marine economic fishes; for example, by quantitative methods, such as those of Hensen, and with special reference to the most important species, such as plaice, cod and haddock, herring, etc. (See Appendix I.)

(*b*) Continued investigation of the life-history and conditions of life of young fishes of economic species in their post-larval stages and till they reach maturity, with special reference to their local distribution.

(*c*) Systematic observation of mature marketable fishes with reference to their local varieties and migrations, their conditions of life, nourishment (as, for instance, by investigation of the contents of the stomach), and natural enemies: also observations on the occurrence and nature of fish food at the bottom, the surface and intermediate waters down to depths of at least 600 metres. (See Appendix I.)

(*d*) Determination of periodic variations in the occurrence, abundance, and average size of economic fishes, and the causes of the same.

II.

(*a*) Experimental fishings *on* the known fishing grounds during the time of the fishery, as well as *outside* these areas and seasons.

(*b*) Preparation of uniform statistics of the experimental catches, with particulars of the number, species, size, weight, and condition of the fish; for example, as done on board the *Garland* by the Scottish Fishery Board.

(*c*) The uniform use of appropriate apparatus for the experimental capture of the different species and sizes of fish.

(*d*) The experimental marking and liberation of fish, for instance of plaice, on as large a scale as possible and over extensive areas; for example, as carried out by Dr. C. G. Joh. Petersen and Dr. T. W. Fulton (Reports of the Danish Biological Station and the Fishery Board for Scotland), and others. (See Appendix IV.)

III.

(*a*) It is desirable to collect uniform statistics of the number, weight, and value of the fish landed, of the means of capture, and of the persons engaged in the industry; for example, as in the General Reports of the Scottish Fishery Board.

(*b*) It is desirable to collect material for the preparation of maps, showing the fishing grounds and the kinds of fishing there practised. (Cf. A. VIII.)

C.

ORGANISATION OF A CENTRAL BUREAU.

I.

The Conference recommends that there should be for the international hydrographical and biological researches of the seas an international council with a central bureau, furnished with a laboratory. (See Appendix II.) The central bureau will be:—

(*a*) To give uniform directions for the hydrographical and biological researches in accordance with the resolutions drawn up in the programme of the present Conference, or in accordance with such modifications as may be introduced later with the consent of the States represented.

(*b*) To control the apparatus and to ensure uniformity of methods.

(*c*) To undertake such particular work as may be entrusted to it by the participating Governments.

(*d*) To publish periodical reports and papers which may prove useful in carrying out the co-operative work.

(*e*) To decide the graphic representations, scales, signs, and colours to be used in the charts for the purpose of obtaining uniformity in the publications.

(*f*) To make, in connection with the investigations, application to the telegraph administrations for the purpose of obtaining determinations from time to time of the changes in the resistance of the cables which cross the areas in any direction.

II.

(*a*) The permanent International Council should consist of commissioners elected by the Governments interested. Each Government may appoint two commissioners, who may be represented at meetings by substitutes.

(*b*) The Council elects its president and vice-president, and appoints all officials connected with the central bureau. Should the general secretary represent hydrographical sciences, his principal assistant should represent the biological sciences, or *vice versâ*.

(*c*) The Council shall draw up its own order of proceedings.

(*d*) The expenses of the central office are approximately estimated £4,800 (96,000 marks) yearly.

(*e*) The place of the central bureau, to be decided by the Governments concerned, shall at the same time be the residence of the general secretary, and should be conveniently situated for hydrographical and biological researches.

(*f*) It will be for the Governments concerned to decide among themselves the share to be borne by each.

Scheme for the expenditure of the Central Bureau.

	£
1. General Secretary	750
2. Principal Assistant	500
3. President, for incidental expenses other than travelling expenses	200
4. Vice-President, for incidental expenses other than travelling expenses	100
5. Office, laboratory, scientific and technical assistants, draughtsmen, clerks, servants, postage, telegrams, and similar expenses	2,250
6. Travelling expenses	300
Note : Travelling expenses of commissioners attending meetings of the Council shall be borne by their respective Governments.	
7. Printing	500
8. Incidental expenses	200
	£4,800

D.

It is desirable that these investigations should begin May 1st, 1901.

E.

The Conference declares that it is of the greatest importance, both for high-sea fisheries and for the weather forecasts for long periods, that the Faröe Islands and Iceland should be included in the European telegraph system as soon as possible.

F.

The relation between the quantity of halogen contained in the water and the density of the water shall be carefully investigated by an experimental revision of the tables compiled by Knudsen (Ingolf Exp. II. 37). The tables compiled by Makaroff, Krümmel, and others for the relation of specific gravity to density and salinity are likewise in urgent need of experimental revision.

It is proposed to undertake these investigations in the technical institute at Copenhagen under the direction of a committee, consisting of Messrs. Sir John Murray, Knudsen, Pettersson, Nansen, Krümmel, H. N. Dickson, and Makaroff. The means for carrying out these works are to be requested from such learned societies as have funds for such purposes.

G.

The Conference recommends that these resolutions be brought by the nations concerned to the knowledge of the Governments of France and Belgium.

H.

In case the resolutions of the Conference should be accepted by the States, it is anticipated that some length of time will elapse before the organisation of the central bureau is completed. In the meantime the Governments may wish to possess an organisation in connection with this Conference which may be useful in constituting the Council and the central bureau.

The members of the third Committee, Åkerman, Drechsel, Von Grimm, Herwig, Hoek, J. Murray, Nansen, Pettersson, hereby offer their services for this purpose.

STOCKHOLM, *June* 23*rd*, 1899.

APPENDIX I.

In the quantitative estimation of pelagic fish eggs, and of the free-swimming larval stages that proceed from eggs, whether pelagic or demersal, the following considerations have to be kept in view:—

1. According to our present knowledge these floating objects are distributed over somewhat extensive areas, by the agency of winds, waves, and currents, in such a manner that a reasonable approximation of the total number of eggs present within the whole area may be arrived at by means of samples taken at certain points.

2. Since the stages of development are not confined to the surface-water, but partly, in the case of the riper eggs and larvæ, float deeper down, the net must be drawn, for purpose of quantitative estimation, in a *vertical* direction.

3. The several series of observations must be carried out in a uniform manner in order that the results may be comparable. An example of the method of procedure lies to hand in the "Bericht der Kommission zur Untersuchung der deutschen Meere" on the experimental cruises

undertaken by the German Seefischereiverein in the North Sea in the beginning of 1895, and minutely described by Hensen and Apstein.

The method employed is as follows: A funnel-shaped net with a ring $1\frac{1}{2}$ metre in diameter, and capable of folding or closing up, and with a bag, to the end of which a beaker is attached, is let down perpendicularly to the bottom and then drawn up, until it hangs at the side of the ship. The net is then rinsed with a jet of water, so that its entire contents are washed down into the beaker at its extremity; the beaker is then detached and its contents removed.

It is usually impossible to examine this material at once, and it must consequently be suitably preserved for study ashore. The method of preservation should likewise be identical throughout the whole series of researches, as also should be the size and mesh of the net. The net is constructed of miller's gauze (or "bolting-cloth"), No. 3, as already used in the German deep-sea expeditions.

4. The ship has to be laid on a determined course, and an observation taken at least every twenty knots. If at the first glance eggs are present in considerable numbers in the catch (in which case over 200 eggs will be present), it will be necessary to take samples at shorter intervals, according to the judgment of the person in charge.

5. The eggs so obtained must be examined on shore for the purpose of estimating their number, and, so far as possible, of determining their species.

Specific determination of the larvæ, and even of the embryos in the eggs, is admittedly possible, and for such determination the works of M'Intosh, of Apstein, and the forthcoming publications of the Heligoland station, will afford material. The young eggs of the plaice, sole, etc., can be identified and therefore enumerated, while the eggs of the cod and haddock in the early stages of their development cannot, with our present knowledge, be distinguished from each other.

6. It is to be supposed that the hydrographic cruises in February, May, August, and November will also furnish material for determining the occurrence of eggs and larvæ, and will indicate when the time is come, or is approaching, for the commencement of systematic observation of the eggs. Since the spawning period differs somewhat in different years and in different parts of the sea, an agreement as to new courses of investigation in special areas of the various seas must be arranged through the central bureau or otherwise, on the basis of the results obtained during the hydrographic and other cruises.

7. Other methods for the numerical estimation of eggs and larvæ are by no means to be excluded, but should not interfere with or supplant the methods of research determined by international agreement.

HENSEN.

APPENDIX II.

In connection with the central bureau there should be a central laboratory, where, amongst other things, the following work might be carried out:—

1. The various methods for determining salinity, temperature, gases, plankton, etc., of the sea should be carefully tested, in order that standard methods may be fixed.

2. The various apparatus and instruments now used for hydrographical and biological research should be examined in order to settle which are the most trustworthy. Experiments may also be made to improve the apparatus and instruments, or to construct new and better ones.

3. Instruments and apparatus used in the investigations should be approved and tested at certain intervals at the central laboratory.

4. The water-samples sent by the workers of the participating states should be analysed and examined at the central laboratory, from which also samples of standard water should be provided. (See A. IV.).

5. If desired the water-, plankton-, or bottom-samples collected by the expeditions of the participating states could be examined at the laboratory on payment of a sum to be fixed by the international council.

6. In the central laboratory various important investigations of general interest for the hydrographical and biological researches may be carried out; *e.g.* analyses of the relation between the various saline constituents of the sea-water in the different parts of the ocean, analyses of the nature and quantity of plankton, as proposed by Prof. Cleve.

7. Facilities should be afforded to the participating states for sending students to the central laboratory to be trained for hydrographical and biological work.

8. The investigators of the participating states, or special expeditions, might, if desired, be supplied from the central laboratory with instruments, apparatus, and typical specimens of organisms and deposits for hydrographical and biological research at cost price.

FRIDTJOF NANSEN.

APPENDIX III.

ABOUT PLANKTON INVESTIGATIONS.

I. For estimating the amount of plankton I propose that a method be adopted founded on the following principles:—

1. Separation of the organic matter in a certain quantity of water, by means of centrifuge or by filtration.

2. Determination of the amount of carbon and nitrogen by combustion of the residuum in a vacuum tube by means of cupric oxide, and determination of the nitrogen and the dioxide of carbon.

P. T. CLEVE.

II. As it is desirable to know the amount of fat in the plankton, we propose that a sample from each station be dried and extracted with ether. A small quantity of the non-extracted material may be tested on carbon or nitrogen, so that the total amount of fat in a certain quantity of water can be calculated, the amount of organic carbon or nitrogen (proposal I.) being known.

O. PETTERSSON.
P. T. CLEVE.

III. It seems desirable that a systematic examination of the plankton close above the bottom be carried out, especially on the fishing-banks.

P. T. CLEVE.

IV. It seems desirable to examine the bottom-fauna (benthos) of the fishing-banks of the North Sea *at different seasons;* for instance, by counting the animals present in a certain volume of the mud, or on a certain area of the bottom.

P. T. CLEVE.

V. It seems to be of a certain importance to determine the amount of carbon (organic), nitrogen, sulphur, and phosphorus in the bottom-mud of the fishing-banks.

P. T. CLEVE.

APPENDIX IV.

MARKING OF FISHES IN THE WATERS OF THE REGION OF THE BALTIC AND THE NORTH SEA.

The marking of fishes in order to facilitate a systematic control and investigation as to their migrations and growth, and also to the periodicity and frequency of their spawning seasons, is, in most cases, to be regarded as the most certain and direct means of arriving at reliable and satisfactory conclusions. The method of marking salmon, already known and practised in Great Britain a number of years ago, has of late, for some ten years, been taken up and carried on in Norway, as may also have been the case in some of the other countries here represented. In Denmark the marking of plaice has been practised of late years. As to Sweden, it has been proposed and agreed upon more than once that such a proceeding ought to be more generally and methodically made use of, as, for instance, at the general conferences on questions regarding the fisheries of Sweden, held at Gothenburg and Stockholm in 1891 and 1897, when, at both those occasions, there were also present several distinguished specialists as representatives of the other Scandinavian countries; but this plan, although unanimously assented to and approved of, has nevertheless not as yet been carried into execution, owing perhaps to a certain extent to the circumstance of there not being any common plan and method of marking adopted for the whole Baltic region, a condition which was especially made an essential point of by the Stockholm Conference.

Being of opinion that the question of marking fishes, more especially of the different species of sea-salmon and flat-fish, and also, if possible, other kinds of fishes of all the coasts and waters of the different countries represented at this meeting, no doubt belongs to the competence of this Conference, and still more, when considering that there are some most distinguished gentlemen here present, being of unquestionable renown as specialists on this subject, I beg to propose that this question be admitted on the programme of the meeting in order to be duly discussed and decided upon according to circumstances.

FILIP TRYBOM.

STOCKHOLM, *June* 14*th*, 1899.

List of Publications Recording the Results of Researches carried out under the Auspices of the Marine Biological Association of the United Kingdom in their Laboratory at Plymouth or on the North Sea Coast from 1886–1900.

THE following list has been classified, so far as practicable, according to subjects, in order that it may be useful for purposes of reference. The list does not include publications recording the results of observations made on material supplied by the Association to workers in different parts of the country, of which a considerable amount is sent out each year.

In attempting to distinguish between economic and more purely scientific publications considerable difficulty has been experienced; indeed such a distinction is in reality impossible, since all researches bearing on the distribution and habits of marine life of any kind have a more or less direct bearing on fishery problems. All papers dealing with the distribution, habits, and young stages of fishes have been included in the economic division, whether the fishes are themselves marketable or not.

Economic Publications.

FISHES.

I. *General.*

The Natural History of the Marketable Marine Fishes of the British Islands. Prepared by order of the Council of the Marine Biological Association especially for the use of those interested in the Sea-Fishing Industries. By J. T. Cunningham, M.A. With a preface by E. Ray Lankester, M.A., LL.D., F.R.S. London: Macmillan and Co., Ltd., 1896.

The Ovaries of Fishes. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 154.

On the Histology of the Ovary and of the Ovarian Ova in certain Marine Fishes. By J. T. Cunningham, M.A. Quart. Journ. Micr. Sci. XL. 1897, p. 101.

A Contribution to the Knowledge of the Ovary and Intra-ovarian Egg in Teleosteans (with Plates XI. and XII.). By W. L. Calderwood. Journ. M.B.A. N.S. ii. 1891–92, p. 298.

A Record of the Teleostean Eggs and Larvæ observed at Plymouth in 1897. By E. W. L. Holt and S. D. Scott, B.A. Journ. M.B.A. N.S. v. 1897–99, p. 156.

Studies on the Reproduction and Development of Teleostean Fishes occurring in the neighbourhood of Plymouth (with Plates I.–VI.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S i. 1889–90, p. 10.

On some Larval Stages of Fishes (with Plates III. and IV.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 68.

On Some Disputed Points in Teleostean Embryology. By J. T. Cunningham, M.A. Ann. and Mag. Nat. Hist. 1891.

Recherches sur la Reproduction des Poissons osseux. Par E. W. L. Holt. Ann. Mus. Hist. Nat. Marseille, v., 1899.

Preliminary notes on the Reproduction of Teleostean Fishes in the South-Western District. By E. W. L. Holt. Journ. M.B.A. N.S. v. 1897–99, p. 41.

Notes on the Reproduction of Teleostean Fishes in the South-Western District. By E. W. L. Holt and L. W. Byrne, B.A. Journ. M.B.A. N.S. v. 1897–99, p. 333.

Notes on the Reproduction of Teleostean Fishes in the South-Western District. By E. W. L. Holt. Journ. M.B.A. N.S. v. 1897–99, p. 107.

Report on a Collection of Very Young Fishes obtained by Dr. G. H. Fowler in the Faeroë Channel. By E. W. L. Holt. Proceed. Zool. Soc., London. 1898, p. 550.

The Rate of Growth of some Sea Fishes and their Distribution at Different Ages. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 95.

On the rate of Growth of some Sea Fishes and the Age and Size at which they begin to breed. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 222.

Report on the Probable Ages of Young Fish collected by Mr. Holt in the North Sea. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 344.

On the Relation of Size to Sexual Maturity in Pleuronectids. (North Sea Investigations.) By E. W. L. Holt. Journ. M.B.A. N.S. ii. 1891–92, p. 363.

On the Relation of Size to Sexual Maturity in Round-fish. (North Sea Investigations.) By E. W. L. Holt. Journ. M.B.A. N.S. iii. 1893–95, p. 78.

On the Relations of the Generative Organs and of the Sexes in some Fishes. (North Sea Investigations.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 28.

An Examination of the Present State of the Grimsby Trawl Fishery, with especial reference to the Destruction of Immature Fish. By E. W. L. Holt. Journ. M.B.A. N.S. iii. 1893–95, p. 339. (Cf. N.S. iv. 1895–97, p. 410.) Also issued as a separate publication.

Destruction of Immature Fish. By G. C. Bourne, M.A. Journ. M.B.A. N.S. i. 1889–90, p. 153.

On the Destruction of Immature Fish in the North Sea. Remedial Measures. (North Sea Investigations.) By E. W. L. Holt. Journ. M.B.A. N.S. ii. 1891–92, pp. 380, 388.

The Immature Fish Question. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 54.

Growth and Distribution of Young Food-fishes. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 272.

On the Destruction of Immature Fish in the North Sea. (North Sea Investigations.) By E. W. L. Holt. Journ. M.B.A. N.S. iii. 1893–95, pp. 81, 123, 169, 288.

Statistics of Small Fish landed at Grimsby. (North Sea Investigations.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 10.

The Impoverishment of the Sea. By W. Garstang, M.A. Journ. M.B.A. N.S. vi. 1900, p. 1.

Notes on the Fishing Industry of Plymouth. By Walter Heape, M.A. Journ. M.B.A. Old Series. No. 1. 1887, p. 45.

Monthly Reports on the Fishing in the neighbourhood of Plymouth (with 8 charts). By W. L. Calderwood. Journ. M.B.A. N.S. ii. 1891–92, p. 277 and p. 394. N.S. iii. 1893–95, p. 107.

Preliminary Note on Trawling Experiments in certain Bays on the South Coast of Devon. By F. B. Stead, B.A. Journ. M.B.A. N.S. iv. 1895–97, p. 90.

Report on Trawling in Bays on the South Coast of Devon. By E. W. L. Holt. Journ. M.B.A. N.S. v. 1897–99, p. 296.

Notes on Rare or Interesting Specimens (*Clupea alosa*, *Auxis Rochei*, *Thynnus thynnus*, *Myliobatis aquila*). By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 274.

North Sea Investigations. Preliminary. By E. W. L. Holt. Journ. M.B.A. N.S. ii. 1891–92, p. 216.

On the Territorial Fishing Ground of Scarborough and its Neighbourhood. (North Sea Investigations.) By E. W. L. Holt. Journ. M.B.A. N.S. iii. 1893–95, p. 176.

On the Iceland Trawl Fishery, with some Remarks on the History of the North Sea Trawling Grounds. (North Sea Investigations.) By E. W. L. Holt. Journ. M.B.A. N.S. iii. 1893–95, p. 129.

Two Trips to the Eastern Grounds. (North Sea Investigations.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 33.

Notes on the General Course of the Fishing. (North Sea Investigations.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 12.

Observations at Sea and in the Markets — Grimsby, Scarborough, Hull, Lowestoft. (North Sea Investigations.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 108.

Account of a Voyage in the Smack *Albert* to the Newfoundland Fishing Banks. By W. T. Grenfell, M.R.C.S. Journ. M.B.A. N.S. iii. 1893–95, p. 143.

Causes of the Observed Distribution of Fish in the North Sea. (North Sea Investigations.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 133.

Physical and Biological Conditions in the North Sea. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 233.

Recent Experiments Relating to the Growth and Rearing of Food-fish at the Laboratory. ii. The Rearing of Larval Fish. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. i. 1889–90, p. 370.

Breeding of Fish in the Aquarium. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 195.

Experiments on the Rearing of Fish-Larvae in the Season of 1894. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 206.

Growth of Fishes in the Aquarium. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 167.

Rearing of Fish-Larvae. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 168.

Experiments on Sea-Fish Culture. By W. Garstang, M.A. Report Brit. Assoc., 1899.

Preliminary Experiments on the Rearing of Sea-Fish Larvae. By W. Garstang, M.A. Journ. M.B.A. N.S. vi. 1900, p. 70.

The Sense-Organs and Perceptions of Fishes, with Remarks on the Supply of Bait (with Plate XX.). By W. Bateson, M.A. Journ. M.B.A. N.S. i. 1889–90, p. 225.

Modes in which Fish are affected by Artificial Light. By W. Bateson, M.A. Journ. M.B.A. N.S. i. 1889–90, p. 216.

Experiments on the Production of Artificial Baits. By Frank Hughes. Journ. M.B.A. N.S. ii. 1891–92, pp. 91 and 220.

Notes on How Fish Find Food. (Report on the occupation of Table.) By Gregg Wilson, M.A., B.Sc. Report Brit. Assoc., 1893, p. 548.

The Amount of Fat in Different Fishes. By F. Hughes. Journ. M.B.A. N.S. ii. 1891–92, p. 196.

The Vernacular Names of Common Fishes. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. i. 1889–90, p. 92.

The Regulations of the Local Sea Fisheries Committees in England and Wales. By E. J. Allen, B.Sc. Journ. M.B.A. N.S. iv. 1895–97, p. 386.

2. *The Eel Family.*

The Breeding of the Conger. By J. T. Cunningham, M.A. Journ. M.B.A., Old Series, No. 2. 1888, p. 245.

On the Reproduction and Development of the Conger. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 16.

On a Specimen of *Leptocephalus Morisii.* By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 73.

Sudden Colour-changes in Conger. By W. Bateson, M.A. Journ. M.B.A. N.S. i. 1889–90, p. 214.

The Larva of the Eel. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 278.

The Reproductive Maturity of the Common Eel. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 87.

Eels and Sticklebacks in Sea-water. By W. L. Calderwood. Journ. M.B.A. N.S. ii. 1891–92, p. 77.

Note on *Muraena helena*, Linn. By E. W. L. Holt. Journ. M.B.A. N.S. v. 1897–99, p. 91.

3. *The Herring Family.*

Anchovies in the English Channel (with an illustration in the text). By J. T. Cunningham, M.A. Journ. M.B.A. N.S. i. 1889–90, p. 328.

Probable Relation between Temperature and the Annual Catch of Anchovies in the Schelde District (with Plate XXIV.). By G. H. Fowler, B.A., PH.D. Journ. M.B.A. N.S. i. 1889–90, p. 340.

Experiments on the Relative Abundance of Anchovies off the South Coast of England. By W. L. Calderwood. Journ. M.B.A. N.S. ii. 1891–92, p. 268.

The Migration of the Anchovy. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 300.

Ichthyological Contributions. iv. Growth of Young Herring in the Thames Estuary. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 330.

On the Occurrence of Large Numbers of Larval Herrings at the Surface. By Matthias Dunn. Journ. M.B.A. N.S. v. 1897–99, p. 184.

Notes on the Herring, Long-line and Pilchard Fisheries of Plymouth during the Winter 1889–90. By W. Roach. Journ. M.B.A. N.S. i. 1889–90, p. 382.

Notes on Herring, Long-line and Pilchard Fisheries of Plymouth. By W. Roach. Journ. M.B.A. N.S. ii. 1891–92, p. 180.

The Spawn of the Pilchard. By J. T. Cunningham, M.A. Journ. M.B.A. Old Series, No. 2. 1888, p. 247.

The Reproduction and Growth of the Pilchard (with Plate X.). By J. T. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 151.

Year-old Pilchards. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 398.

The Life History of the Pilchard. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 148.

4. *The Salmon Family.*

The Great Silver Smelt, *Argentina silus*, Nilsson, an addition to the List of British Fishes. By E. W. L. Holt. Journ. M.B.A. N.S. v. 1897–99, p. 341.

Grayling and Loch Leven Trout in Salt Water. By W. L. Calderwood. Journ. M.B.A. N.S. v. 1891–92, p. 76.

5. *Flat-fish Family.*

Diagnostic characters in Flat Fishes. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 247.

The Development of the Egg in Flat Fishes and Pipe-fishes. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iii. 1893–95, p. 258.

A Treatise on the Common Sole (*Solea vulgaris*), considered both as an organism and as a commodity. Prepared for the Marine Biological Association of the United Kingdom. By J. T. Cunningham. M.A., Plymouth. Published by the Association. 1890 (4to. pp. 147 with eighteen plates).

Reproductive Organs of the Common Sole. By J. T. Cunningham, M.A. Journ. M.B.A. Old Series, No. 2. 1888, p. 248.

Ichthyological Contributions. ii. On a Stage in the Metamorphosis of Solea. By J. Cunningham, M.A. Journ. M.B.A. N.S. ii. 1891–92, p. 327.

Report on the Spawning of the Common Sole in the Aquarium of the Marine Biological Association's Laboratory during April and May, 1895. By G. W. Butler, B.A. Journ. M.B.A. N.S. iv. 1895–97, p. 3.

The Size of Mature Plaice, Turbot, and Brill on different Fishing Grounds. (North Sea Investigations.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 97.

On the Peculiarities of Plaice from different Fishing Grounds. By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 315.

Observations on the Natural History of Plaice. (North Sea Investigations.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 15.

Proposed Restrictions on the Landing of Undersized Plaice in the light of the New Evidence. (North Sea Investigations.) By J. T. Cunningham, M.A. Journ. M.B.A. N.S. iv. 1895–97, p. 138.

On a Dwarf Variety of the Plaice, with some Remarks on the Occasional Ciliation of the Scales in that Species. (North Sea Investigations.) By E. W. L. Holt. Journ. M.B.A. N.S. iii. 1893–95, p. 194.

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Marine Biological Association of the United Kingdom.

Report of the Council, 1898–99.

The Council and Officers.

There have been four ordinary meetings of the Council during the year, at which the average attendance has been 8. As in previous years, the meetings have been held at the rooms of the Royal Society, and the Council has again to express its thanks for the courtesy thus extended.

The Council has to record with regret the death of Professor G. J. Allman, F.R.S., who has been one of the Vice-Presidents of the Association since its foundation in 1884.

The Plymouth Laboratory.

The Laboratory continues in a state of efficiency, and is adequately equipped with all the most modern requirements necessary for the prosecution of scientific researches in the various branches of marine bionomics and of the morphology of marine animals and plants.

The tank-room has undergone considerable rearrangement, and has been well stocked with a variety of fishes and of invertebrates, a number of species which have not previously been kept alive for lengthened periods having successfully survived the winter.

The pumps and engines which supply the sea-water and circulate it in the tanks have worked satisfactorily throughout the year, and only repairs due to ordinary wear and tear have been required.

Both the tanks and the Association's exhibition collection of preserved specimens have been open to the public on payment of a small charge, and have been seen by a large number of visitors.

The Laboratory has continued to supply living and preserved specimens of marine organisms to naturalists in all parts of the country for use in their investigations, as well as to numerous teaching institutions and museums for educational purposes.

The Boats.

The Association's steamboat *Busy Bee* has continued to carry on the regular collecting work of the station in the neighbourhood of Plymouth and on the adjoining coast. On two occasions Mr. Garstang, with the aid of a grant made by the British Association, has hired the steam-tug *Stormcock* for runs to Ushant and Parson's Bank, in connection with his researches on the temperature and floating fauna of the waters at the mouth of the Channel.

The Staff.

Mr. Holt, who has been appointed to take charge of the fishery investigations of the Royal Dublin Society, has left Plymouth for the West of Ireland. By arrangement with the Royal Dublin Society, Mr. Holt will still retain his position of Honorary Naturalist on the staff of the Marine Biological Association.

Mr. R. A. Todd, B.Sc., has been appointed Assistant to the Director at a salary of £80 per annum.

In other respects the staff remains as it was last year.

The Library.

The Library continues to grow, and it has been again necessary to increase the shelf accommodation.

The Council has been fortunate in securing a most useful collection of monographs and pamphlets on the Hydrozoa and Polyzoa from the library of the late Rev. Thomas Hincks.

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the year:—

Transactions and Proceedings of the Royal Society of London.
Transactions and Proceedings of the Zoological Society of London.
Zoological Record.
Report of the British Association for the Advancement of Science. (Bristol, 1899.)
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Quarterly Journal of Microscopical Science. (Presented by Messrs. J. and A. Churchill.)
Report of H.M. Inspectors of Fisheries. (England and Wales.)
Catalogue of the Radcliffe Library, Oxford.
Annual Report of the Horniman Museum.
The Fisherman's Nautical Almanack and Tide Table. (O. T. Olsen, Grimsby.)
Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands, and elsewhere. Dr. A. Willey.
The Cambridge Natural History. (Presented by the Editors.)

Transactions and Proceedings of the Royal Society of Edinburgh.
Proceedings of the Scottish Microscopical Society.
Report of the Millport Marine Biological Station.
Annual Report of the Fishery Board for Scotland.
On Stocking Rivers, Streams, etc., with Salmonidae. Howietown Fishery Company.
Scientific Transactions of the Royal Dublin Society. (Presented by the Director of the Royal Gardens, Kew.)
Proceedings of the Royal Irish Academy.
Report of the Inspectors of Irish Fisheries.
Proceedings and Transactions of the Liverpool Biological Society.
Report of the Port Erin Biological Station.
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Bulletin de la Marine Marchande.
Bulletin Scientifique de la France et de la Belgique.
Bulletin de la Société Zoologique de France.
Mémoires de la Société Zoologique de France, i.–v. *Bulletin de la Société Zoologique de France*, i.–xvii. (Presented by Sir John Murray.)
Bulletin de la Société Centrale d'Aquiculture et de Pêche.
La Feuille des Jeunes Naturalistes.
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Bulletin de l'Academie Royale des Sciences et des Lettres de Danemark.
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Memoirs from the Biological Laboratory of the Johns Hopkins University.
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Bulletin of the Laboratories of Natural History, State University of Iowa.
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Annual Report of the Director of the Board of Trustees of the Field Columbian Museum.
Publications of the Field Columbian Museum.
Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University.
Report of the Missouri Botanical Garden.
Proceedings of the Boston Society of Natural History.
Bulletin of the Buffalo Society of Natural Sciences.
Proceedings of the Natural History Association of Miramichi.
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Comunicaciones del Museo Nacional de Buenos Aires.
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Journal of the College of Science, University of Tokyo.
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Journal of the Fisheries Society of Japan.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library :—

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On the Identification of Fish Artificially Hatched. H. C. Bumpus.
Notes on a Tetramerous Specimen of Echinus esculentus. H. C. Chadwick.
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Methode der Morphologie. Hans Driesch.
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On the Relations of Certain Stichodactylinæ *to the Madreporaria.* J. E. Duerden.
The Destruction of Immature Fish. Matthias Dunn.
Observations sur L'Arenicola ecaudata, *Johnston.* Pierre Fauvel.
Plankton of the Faroe Channel. G. H. Fowler.
Photographic Records of Pedigree Stock. Francis Galton.
Early Development of Polychœrus caudatus, *Mark.* E. G. Gardiner.
The Growth of the Ovum, Formation of Polar Bodies, and the Fertilization in Polychœrus caudatus. E. G. Gardiner.
The Building of Atolls. J. Stanley Gardiner.
On the Solitary Corals Collected by Dr. A. Willey. J. Stanley Gardiner.
Coral Reefs of Funafuti, Rotuma, and Fiji. J. Stanley Gardiner.

Natural History Notes. H. M. Indian Marine Survey: and Six Papers on Crustacea. Surg.-Maj. G. M. Giles.

Notes sur un Nématode nouveau des Iles Fiji. G. Gilson.

On the Reno-pericardial Canals in Patella. E. S. Goodrich.

The Metamorphosis of Asterias pallida, *with special reference to the fate of the Body Cavities.* S. Goto.

Bestimmungsschlussel für die Indo-Malayischen Landplanarien. L. von Graff.

L'État moniliforme des neurones chez les Invertebrés. J. Havet.

La Girelle royale et la Girelle de Giofredi doivent elles toutes deux être rapportées à l'espèce dimorphique Coris julis (Linn)? E. W. L. Holt.

Report on a Collection of very Young Fish obtained by Dr. G. H. Fowler in the Faeroe Channel E. W. L. Holt.

On Siriella armata *and the reputed occurrence of* S. frontalis *in British Seas.* E. W. L. Holt and W. I. Beaumont.

On the Variability of Characters in Perichaetidae. R. Horst.

On Perichaeta Sieboldi *Horst.* R. Horst.

Aspidosiphon cylindricus. N. Sp. R. Horst.

Contributions to the Anatomy and Histology of Thalassema neptuni. H Lyster. Jameson.

Études sur les Fourmis les Guêpes et les Abeilles. C. Janet.

The Fishing Industry of Japan. K. Kishinouye.

Hints on the Construction of a Tow-net. C. A. Kofoid.

The Freshwater Biological Stations of America. C. A. Kofoid.

The Freshwater Pearls and Pearl Fisheries of the United States. G. F. Kunz.

Beiträge zur Kenntniss der Pedalion-Arten: and five other papers. K. M. Lavender.

Les "Sphères attractives" et le Nebenkern des Pulmonés. A. Bolles Lee.

Spongia (Zool. Centralblatt). R. v. Lendenfeld.

On the Detection and Localization of Phosphorus in Tissue Elements. A. B. Macallum.

On the Gastric Gland of Mollusca and Decapod Crustacea. C. A. MacMunn.

The Pigments of Aplysia punctata. C. A. MacMunn.

On the Origin of the Vertebrate Notochord and Pharyngeal Clefts. A. T. Masterman.

Fourteen Papers on Fishery and Morphological Researches. A. T. Masterman.

The Land Isopoda of Madeira. A Second Recent Shell of Helix Lowei. British Isopoda Chelifera. Museum Normanianum. Rev. Canon Norman.

On Three New Species of Hydroids and one new to Britain. C. C. Nutting.

The Colour of Deep-Sea Animals. C. C. Nutting.

Hydroids from Alaska and Puget Sound. C. C. Nutting.

Observations on the Plankton of Puget Sound. J. I. Peck and N. R. Harrington.

Meteorological Observations, Rousdon, Devon. Sir Cuthbert Peek.

Ueber die Endigung der Nerven im Elektrischen Organ von Raja clavata *and* radiata. Prof. G. Retzius.

The Irish Freshwater Leeches. R. F. Scharff.

Zweckmassigkeit und Anpassung. J. W. Spengel.

Upon the Structure and Development of the Enamel of Elasmobranch Fishes. C. S. Tomes.

On Differences in the Histological Structure of Teeth occurring in a Single Family—the Gadidae. C. S. Tomes.

Degli Studi Intorno Agli Alimenti dei Pesci. G. B. de Toni.

The Relations between Marine Animal and Vegetable Life. H. M. Vernon.

The Relations between the Hybrid and Parent Forms of Echinoid Larvæ. H. M. Vernon.

Crustacea collected by Prof. Herdman in Puget Sound, Pacific Coast of North America. A. O. Walker.
Hippolyte fascigera (Gosse) and *H. gracilis* (Heller). A. O. Walker.
Malacostraca from the West Coast of Ireland. A. O. Walker.

General Report.

The investigation of the natural history of the mackerel, undertaken at the request of H.M. Treasury, has been continued during the year, and a report on the variation, races, and migrations of this fish has been prepared by Mr. Garstang and published in the Journal of the Association. This report establishes clearly that the mackerel of the American and European coasts are two separate races of fish, having different characteristic peculiarities, and also reveals the existence of certain minor peculiarities which appear to distinguish the Irish mackerel from those which inhabit the English Channel and North Sea. The acceptance of these conclusions will profoundly modify the views which have hitherto been prevalent as to the extent of the mackerel's migrations.

Mr. Garstang has also undertaken a study of the physical and biological conditions prevailing in the waters at the mouth of the English Channel, with special reference to the seasonal changes of temperature, the varying set of the currents, and the distribution of the floating and free-swimming organisms which are found at different seasons of the year. It is to be expected that this study will throw light upon the causes which determine the movements of such migratory fishes as the mackerel, the herring, and the pilchard. If this expectation be fulfilled, it will be possible for a naturalist having a properly equipped vessel at his disposal to determine the most probable position of the schools of fishes from his examination of the condition of the water at any given time. Such a result would be of immediate practical benefit to fishermen, as it would lead to the substitution of more intelligent methods of procedure in place of the unsatisfactory empirical practices of the present time.

A final report has been drawn up by Mr. Holt on the examination of the bays on the south coast of Devon, an investigation which was undertaken by the Association at the request of the Devon Sea Fisheries Committee. This report has been submitted to the Committee and also published in the Journal of the Association.

An examination of the fish population in the estuarine waters of the Hamoaze at each season of the year, commenced two years ago by Mr. Holt, has been continued during the present year. Valuable evidence is thus being accumulated on the question of the movements of bottom-living fishes in the inshore waters.

The investigation of the fauna and bottom deposits on the grounds from the neighbourhood of the Eddystone to Start Point, which has been carried on from time to time during the last four years, has been continued by the Director of the Laboratory, and a lengthy paper, illustrated with charts, has been published, embodying the results of this work. Investigations of a similar kind are now being extended to the inshore grounds.

Occupation of Tables.

In addition to the Officers employed by the Association, the following naturalists have been engaged in research work at the Plymouth Laboratory during the year:—

W. I. Beaumont, B.A., Cambridge (Nemertina and Mysidæ).
G. P. Bidder, B.A., Cambridge (Sponges).
G. Brebner, University College, Bristol (Marine Algæ).
E. G. Bullen (General Zoology).
L. W. Byrne, B.A., Cambridge (Teleosteans).
E. G. Gardiner, Ph.D., Woods Holl (Turbellaria).
J. F. Gemmill, M.A., M.B., Glasgow (General Zoology).
Prof. G. Gilson, Ph.D., Louvain (Polychæta).
E. Gurney, B.A., Oxford (Echinoderma).
J. Kimus, Ph.D., Louvain (Crustacea).
Prof. E. W. MacBride, M A., Montreal (Echinoderma).
C. A. MacMunn, M.D., Wolverhampton (Pigment of Aplysia).
J. E. S. Moore, Royal College of Science (Fishing Apparatus).
G. H. Pethybridge, B.Sc., London (Marine Algæ).
T. H. Taylor, M.A., Yorkshire College (Polyzoa).
R. A. Todd, B.Sc., Yorkshire College (General Zoology).
Prof. W. F. R. Weldon, F.R.S., Oxford (Variation of Crustacea).
M. F. Woodward, Royal College of Science (Mollusca).

Eleven students from Oxford, Cambridge, and Eton attended Mr. Garstang's vacation class in Marine Biology.

Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association:—

Bidder, G.—*The Skeleton and Classification of Calcareous Sponges.* Proceed. Roy. Soc., lxiv., 1898, p. 61.

Cunningham, J. T.—*Contributions to the Knowledge of the Natural History of the Lobster and Crab.* Journ. Roy. Inst. Cornwall, xliv., 1898.

Garstang, W.—*Preliminary Note on the Races and Migrations of the Mackerel* (Scomber scomber). Brit. Assoc. Report, Bristol, 1898.

Garstang, W.—*Recherches sur l'Histoire Naturelle du Maquereau.* Congrès International de Pêches Maritimes, Dieppe, 1898.

Holt, E. W. L.—*Report on a Collection of very Young Fishes obtained by Dr. G. H. Fowler in the Faeroe Channel.* Proceed. Zool. Soc. London, June, 1898.

Holt, E. W. L., and Beaumont, W. I.—*On* Siriella armata (*M.-Edw.*) *and the reputed occurrence of* S. frontalis (*M.-Edw.*) *in British Seas.* Ann. Mag. Nat. Hist., Ser. 7, Vol. iii., 1899.

Holt, E. W. L., and Byrne, L. W.—*On* Lepadogaster. Proceed. Zool. Soc. Lond., Nov., 1898.

Jameson, H. L.—*Contributions to the Anatomy and Histology of* Thalassema neptuni, *Gaertner.* Jena, Fischer, 1899.

MacMunn, C. A.—*On the Gastric Gland of Mollusca and Decapod Crustacea: its Structure and Functions.* Proceed. Roy. Soc., lxiv., 1899.

MacMunn, C. A.—*The Pigments of* Aplysia punctata. Journal of Physiology, Vol. xxiv., 1899.

Nutting, C. C.—*On Three New Species of Hydroids and one new to Britain.* Ann. Mag. Nat. Hist., Ser. 7, Vol. i., 1898.

Donations and Receipts.

The Receipts for the year include the grants from H.M. Treasury (£1,000) and the Worshipful Company of Fishmongers (£400), a grant of £25 from the Publication Fund of the Royal Society, Composition Fees (£15), Annual Subscriptions (£142 13*s.*), Rent of Tables in the Laboratory (£33 6*s.*), Sale of Specimens (£207), Admission to the Tank Room (£78). The total income for the year amounts to £1,930 19*s.*

Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1899–1900:—

President.

Prof. E. Ray Lankester, LL.D., F.R.S.

Vice-Presidents.

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The Duke of Abercorn, K.G., C.B.
The Earl of St. Germans.
The Earl of Morley.
The Earl of Ducie, F.R.S.
Lord Tweedmouth.
Lord Walsingham, F.R.S.
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The Right Hon. Joseph Chamberlain, M.P.
The Right Hon. Sir John Lubbock, Bart., M.P., F.R.S.
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Rev. Canon Norman, D.C.L., F.R.S.
Sir Henry Thompson, Bart.
Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S.

Elected Members.

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Prof. D'Arcy W. Thompson, C.B.
Prof. W. F. R. Weldon, F.R.S.

Hon. Treasurer.

J. A. Travers, Esq.

Hon. Secretary.

E. J. Allen, Esq., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council:—

Robert Bayly, Esq.
J. P. Thomasson, Esq.
The Prime Warden of the Fishmongers' Company.
E. L. Beckwith, Esq. (Fishmongers' Company).
Prof. Sir J. Burdon Sanderson, Bart., F.R.S. (Oxford University).
A. E. Shipley, Esq. (Cambridge University).
Sir William Flower, K.C.B., F.R.S. (British Association).

Dr. Statement of Receipts and Expenditure for the Year ending 31st May, 1899. Cr.

Receipts.	£	s.	d.	£	s.	d.
To Balance from last year, being Cash at Bank and in hand				303	7	10
,, H.M. Treasury				1000	0	0
,, Fishmongers' Company				200	0	0
,, Life Member's Composition Fee—Dr. E. G. Gardiner				15	15	0
,, Annual Subscriptions				142	13	0
,, Rent of Tables	33	6	0			
,, Sale of Specimens	207	0	6			
,, Sale of Journal, &c., including Grant of £25 from Royal Society	34	14	5			
,, Admissions to Tank Room	78	3	5			
				353	4	4
,, Interest on Investment				19	6	8
				£2034	6	10

Expenditure.				£	s.	d.	£	s.	d.
By Salaries and Wages—									
Director				200	0	0			
Naturalist				250	0	0			
Director's Assistant				44	0	0			
Wages				509	6	0			
							1003	6	0
,, Stationery, Office Printing, Postages, &c.							116	9	2
,, Printing and Illustrating Journal							56	4	2
,, Sundry Expenses—									
Gas, Water, Coal, &c.	£100	6	0						
Coal for Steam Yacht	43	4	11						
				143	10	11			
Insurance of Steam Yacht, including boiler				12	7	6			
Stocking Tanks, Feeding, &c.				56	9	1			
Glass, Chemicals, Apparatus, &c.	£82	12	8						
Less Sales of Glass, &c.	15	4	6						
				67	8	2			
Maintenance and Renewal of Buildings, Boats, and Nets	£322	2	0						
Less Sales of Nets and Gear	39	11	9						
				282	10	3			
Rates, Taxes, and Insurance				12	15	11			
Boat Hire				5	4	6			
Travelling Expenses				32	2	2			
Library				92	14	4			
							705	2	10
,, Balance forward, being Cash at Bank and in hand, 31st May, 1899							153	4	8
							£2034	6	10

Investment held 31st May, 1899, £500 Forth Bridge Railway 4% Guaranteed Stock.

Examined and found correct,

(Signed) EDWIN WATERHOUSE,
STEPHEN E. SPRING RICE,
FRANK E. BEDDARD,
J. J. LISTER,
} *Auditors.*

Director's Report.

After the completion of the investigation of the fauna and bottom-deposits of the outlying grounds extending from the neighbourhood of the Eddystone to Start Point, a detailed account of which was given in the last number of the Journal of the Association, a systematic investigation upon a similar plan was undertaken of the inshore grounds. The general area originally contemplated for detailed charting may be roughly described as lying between the 30-fathom line and the shore, and extending from the neighbourhood of Bolt Tail to Looe. In such an area the conditions are necessarily much more complicated than those which were met with on the Eddystone to Start grounds, where the depths varied but little from 30 fathoms, and where any effect upon the bottom fauna due to wave action was very slight. A further unfortunate complication has been introduced by the fact that immense quantities of refuse have been deposited all over the grounds immediately to the south and west of Plymouth Sound, by barges working in connection with the harbour improvement schemes in the Hamoaze and at Keyham, as well as by the barges belonging to the Plymouth Corporation, which discharge the refuse from the town. To such an extent has this deposit taken place that many of the most fruitful dredging and trawling grounds in the immediate neighbourhood have been rendered practically unworkable, and we have been compelled to abandon any serious systematic investigation of a considerable portion of the area originally contemplated. This has led to more attention being directed to the grounds to the east and west of that area, and less to those which lie near to Plymouth Sound.

The detailed work in connection with this investigation has been chiefly carried out by Mr. R. A. Todd, who was appointed by the Council, in the autumn of 1898, to act as my assistant. A large amount of information has been collected and systematically recorded, and we hope before long to be in a position to publish a full report of the work.

Mr. Garstang has successfully completed a series of expeditions across the mouth of the English Channel, for the purpose of ascertaining the variations in the physical conditions of the water and in the distribution of the floating fauna at different seasons of the year. The route taken was (1) from Plymouth to Ushant, with stations in mid-Channel (50 fathoms), and off Ushant (60 fathoms); (2) from Ushant in a westerly direction towards the 100-fathom line, with a station near Parson's Bank (75 fathoms); (3) from Parson's Bank northwards towards Mount's Bay, with a station in 50 fathoms; (4) from Mount's Bay to Plymouth. This course was run in February, May, the first week of September, and in November, 1899, and again in February, 1900. Temperature observations were taken at each station at different depths, and collections of the floating organisms were made with nets of various kinds. In connection with this work a net was designed which could be opened and again closed at any required depth, so that what organisms were present in a stratum of water at a particular level could be ascertained. This net, which worked with great effect and precision, will be subsequently described in detail in the Journal, together with the results of the observations made during the expeditions. The expenses of boat-hire in connection with this research were met by a grant made for the purpose by the British Association.

Mr. Garstang has continued his observations on the races and migrations of the mackerel, and the examination of the surface-drift in the Channel by means of floating bottles has also proceeded.

An account of his experiments on the rearing of sea fishes from the larval to the adult form, carried out at the Laboratory last summer, will be found on page 70 of the present number of the Journal. The periodic examination of the fish population in the estuarine waters of the Hamoaze, commenced some years ago by Mr. Holt, has been continued during the last two years, the fishing operations having been kindly undertaken by Mr. Gover, of Saltash.

Through the kindness of Mr. J. W. Woodall, I was enabled, with Messrs. E. T. Browne and W. I. Beaumont, who were working at the Laboratory, in July of last year, to have a week's useful collecting work at Scilly. In addition to personally assisting us in the work, Mr. Woodall placed his steam yacht *Vallota* at our disposal for tow-netting, as well as for moving about amongst the different islands and seeking suitable localities for shore work. The same gentleman has since purchased the hull of a sailing yacht, the *Dawn*, which is being fitted as a small floating Laboratory, and has been placed at our service for the purpose of examining the fauna of the different harbours in the neighbourhood. We propose to take her, during the early part of the present summer, to Salcombe, a place which possesses great interest from the fact that it was the collecting ground of Colonel Montagu in the early part of the century, and many British species were first described from specimens obtained there.

The following is a list of the naturalists who have occupied tables at the Laboratory since the publication of my last report (*Journal M.B.A.*, vol. v. p. 354):—

Aders, W. M., March 20th to April 17th, 1900 (*Hydrozoa*).

Beaumont, W. I., B.A., December, 1898, to May, 1900 (*Nemertina and Crustacea*).

Bidder, G. P., B.A., January 1st to March 31st, 1899 (*Porifera*).

Browne, E. T., B.A., June 21st to August 31st, 1899 (*Medusæ*).

Bullen, E. G., February 20th to June 5th, 1899 (General Zoology).

Byrne, L. W., B.A., May 19th to May 27th, 1899 (Fishes).

Cooper, C. Forster, July 22nd to August 3rd, 1899 (General Zoology).

Cooper, W. F., June 23rd to July 7th, 1899; March 24th to April 14th, 1900 (General Zoology).

Fagan, H., August 19th to September 14th, 1899 (General Zoology).

Gardiner, E. G., October 30th, 1898, to April 28th, 1899 (*Turbellaria*).

Harman, N. Bishop, B.A., M.B., December 29th, 1899, to January 12th, 1900; March 22nd to April 7th, 1900 (Fishes).

Hill, M. D., M.A., January 12th to January 17th, 1900 (*Alcyonium*).

Kimus, J., PH.D., March 25th to August 15th, 1899 (*Crustacea*).

Kent, W. Saville, August 14th to August 18th, 1899 (Fishes).

Lanchester, W. F., B.A., August 15th to September 11th, 1899 (*Phoronis*).

MacBride, Prof. E. W., M.A., May 18th to July 20th, 1899 (*Echinoderma*).

Minchin, Prof. E. A., August 14th to August 23rd, 1899 (*Porifera*).

Philipps, Miss E. G., March 21st to April 10th, 1900 (*Polyzoa*).

Punnett, R. C., B.A., August 19th to September 15th, 1899 (*Elasmobranchs*).

Willey, A., D.SC., April 11th to April 16th, 1900 (*Polychæta*).

Wolfenden, R. N., M.D., April 23rd to June 4th, 1900 (*Plankton*).

Woodcock, H. M., April 3rd to April 18th, 1900 (*Hydrozoa*).

Eleven students attended Mr. Garstang's vacation class in Marine Biology in 1899, and twelve students the class held during the Easter vacation of the present year.

An important improvement in the method of supplying sea-water for experiments in the Laboratory has been made by the carrying out of a scheme for obtaining water from the open sea beyond the Breakwater.

Many experiments in the rearing of marine larvæ during recent years have pointed to the fact that the best results can only be obtained at Plymouth by the use of water taken at some distance from shore; and it has been our practice for some time to bring in water in glass carboys for special work of this kind. By this means, however, only comparatively small quantities of water could be supplied. We have now obtained a tank-boat, capable of carrying about 1,200 gallons, which can be towed by our own steamer. A Tangyes pump (5″ × 3″ × 12″) has been fixed on the rocks below the Laboratory, and is worked by compressed air from our gas engine in the basement. Two wooden tanks, each capable of holding 500 gallons, have been placed on the top story of the western block of the building, and the pump delivers the water from the boat into these tanks. From the tanks it is carried in a glass tube to the main laboratory, where it can be distributed as required. The whole arrangement, which we are just getting into working order, has involved an expenditure of about £150. Towards this amount £100 has been obtained from a Founder's subscription kindly given by Mr. G. P. Bidder, the balance being met out of the ordinary income of the year.

The Library has recently grown considerably. A large number of books and pamphlets, chiefly dealing with Hydrozoa and Polyzoa, were purchased from the library of the late Rev. Thomas Hincks, and Mrs. Hincks has since presented many additional pamphlets.

In the present number of the Journal the recommendations adopted by the important International Fisheries Conference, which met last year at Stockholm, have been reprinted for general information. So far as I am aware, no steps have yet been taken by the various Governments represented for the practical carrying out of the recommendations of the Conference, and it is of the greatest importance that the matter should not be lost sight of.

There will be found on pp. 115 to 135 a list of the various papers and notes published between 1886 and 1899, which contain the results of work done under the auspices of the Marine Biological Association in the Laboratory at Plymouth or on the North Sea Coast. This list has been arranged according to the subjects treated of, and will not only serve to indicate the great number of questions which from time to time have occupied the attention of investigators at Plymouth, but will also be of value to future workers by bringing together observations upon allied subjects, which are at present much scattered.

E. J. ALLEN.

June, 1900.

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NATURALIST ON THE STAFF OF THE MARINE BIOLOGICAL ASSOCIATION.

With Preface by

E. RAY LANKESTER, M.A., LL.D., F.R.S.,

PROFESSOR OF COMPARATIVE ANATOMY IN THE UNIVERSITY OF OXFORD.

OBJECTS

OF THE

Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence, the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff. In no case does any one salary exceed £250.

The Association has received some £31,000, of which £15,000 has been granted by the Treasury. The annual revenue which can be at present counted on is about £1,820, of which £1,000 a year is granted by the Treasury, the remainder being principally made up in subscriptions.

The admirable Marine Biological Laboratory at Naples, founded and directed by Dr. Dohrn, has cost about £20,000, including steam launches, &c., whilst it has an annual budget of £7,000.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

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OF

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THE PLYMOUTH LABORATORY.

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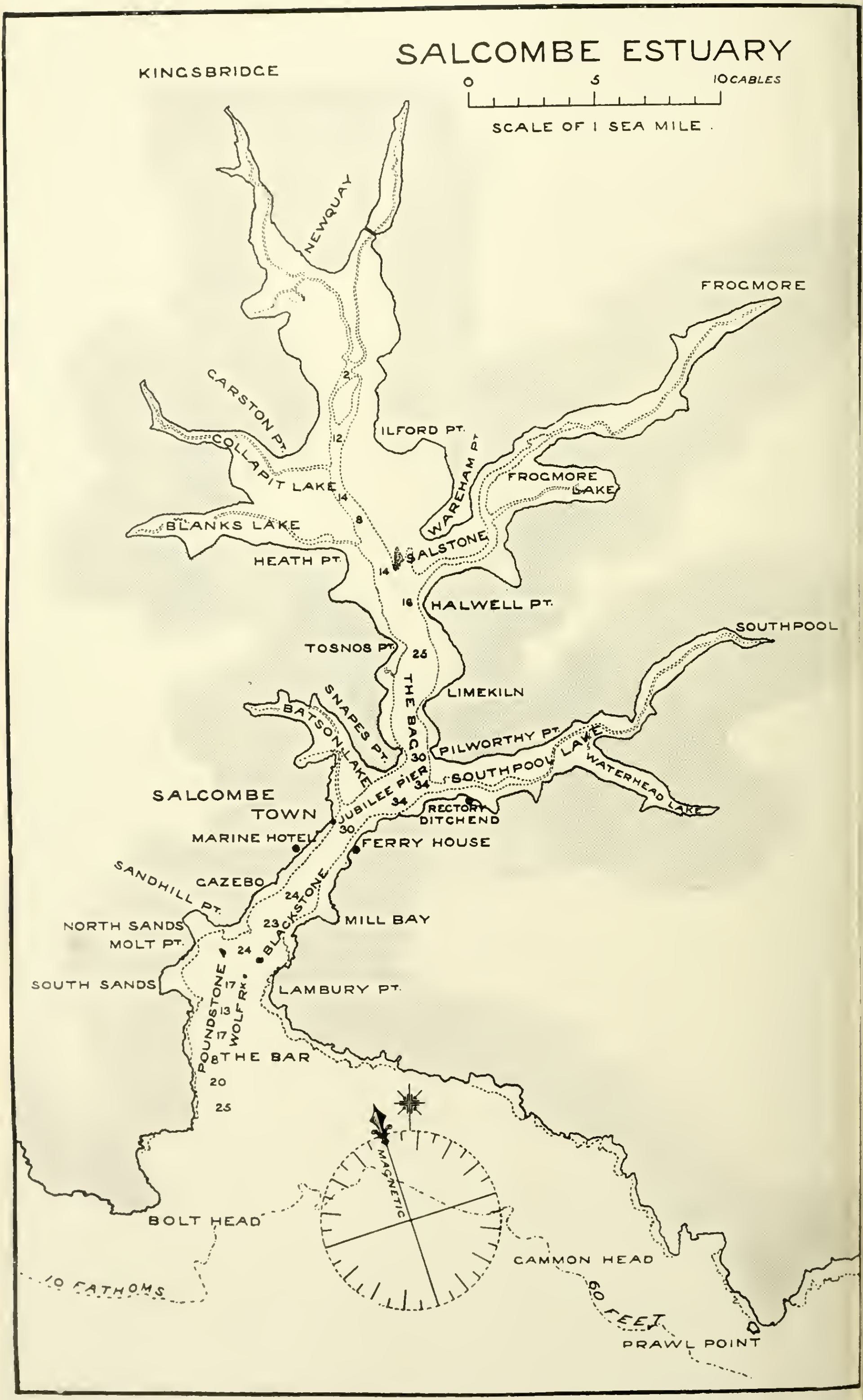
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COLLAPIT LAKE
ILFORD PT.
WAREHAM PT.
FROGMORE LAKE
BLANKS LAKE
HEATH PT.
SALSTONE
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BATSON LAKE
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SOUTH SANDS
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DEC 29 1900

The Fauna of the Salcombe Estuary.

By

E. J. Allen, D.Sc., and R. A. Todd, B.Sc.

With the assistance of W. Garstang, M.A., W. I. Beaumont, B.A.,
T. V. Hodgson, and R. H. Worth.

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I. Introduction.

In connection with the work of the Plymouth Laboratory it has been the custom of the Marine Biological Association for several years past to extend its operations during the summer months to the various harbours on the coast of Devon and Cornwall, with a view to making a comparative study of the faunas found in the different localities and of correlating, so far as that may be possible, differences in the character of the fauna with differences in the physical conditions prevailing in each. In former years this has been done by making occasional visits, lasting generally for a few days only, in our small steamer, the *Busy Bee.* It was found, however, that if investigations of this character were to be satisfactorily carried out some arrangement would have to be made for remaining in one locality for longer periods, and working each harbour in turn in more detail. Mr. J. W. Woodall kindly came to our assistance and purchased the hull of an old cruising yacht, which he caused to be fitted as a small floating laboratory and house-boat, and placed at our disposal for use in connection with the researches. This vessel, the *Dawn*, which can be towed by our own steamer, has been stationed at Salcombe during the present summer and has proved herself to be very well adapted to the work for which she was intended. We have also to thank Mr. Woodall for defraying the expenses of keeping the *Dawn* at Salcombe.

The harbour of Salcombe is of special interest to zoologists from the fact that it was the hunting ground of George Montagu, in the early years of the century, and it was from specimens collected in this locality that many of our marine animals were first made known to science and accurately described. It was partly for this reason, and also because on previous short visits very promising results had been obtained, that we decided to make Salcombe the first of the harbours to investigate in detail. The present report consists almost entirely of a record of facts with regard to the nature and distribution of the fauna as we have found it during the present summer, consideration and discussion of these facts and comparison with the conditions prevailing in other localities being held over until further investigations on a similar plan have been carried out elsewhere.

It is only by a large number of detailed records of this kind, where all possible information is given as to the exact localities and conditions in which each species is found, that we can hope to ascertain the general principles which underlie the distribution of the animals which live in the sea.

In the compilation of the present record a number of naturalists have taken part, and to all these our thanks are due. In the collecting work we had the assistance of Mr. Garstang for several days, as well as Messrs. A. D. Darbishire and W. M. Aders. In the determination of the species there has been considerable division of labour. With the exception of the Polynoida, which were identified by Mr. Hodgson, Mr. Allen is responsible for the Polychæta, which have proved, perhaps, the most interesting group of all, quite a number of Montagu's species being rediscovered, and several new additions being made to British records. The Mollusca were identified by Mr. Todd, as well as the Decapoda, Amphipoda, and Isopoda amongst the Crustacea. Mr. W. I. Beaumont has named the Mysidae, Mr. Garstang and Mr. L. W. Byrne the Fishes, Mr. A. E. Shipley the Gephyrea, Mr. R. C. Punnett and Mr. Beaumont the majority of the Nemertina, and Mr. R. H. Worth the Foraminifera. For the other groups Mr. Allen and Mr. Todd are jointly responsible.

An account of the plankton is not included in the present report, but collections were regularly made and sent to Mr. E. T. Browne, who has undertaken to report upon them.

We are also greatly indebted to Mr. J. Luskey Coad, of Salcombe, a gentleman who during the summer months makes seine and trammel fishing a recreation which he pursues with great diligence, for the account of the fishes which have frequented the harbour during the present summer and of the general character of the fishing.

II. The Physical Conditions Prevailing in the Salcombe Estuary.

For the purposes of this report the whole Salcombe estuary may be conveniently divided into three principal portions, which will be readily recognised on the accompanying chart, and will be referred to as (1) the Kingsbridge estuary, extending from Kingsbridge to Snape's Point; (2) Salcombe Harbour, from Snape's Point to Sandhill Point; and (3) the region between the latter point and the bar, which is generally referred to as "outside the harbour."

In its general geographical features the Salcombe estuary resembles many of the other estuaries on the south coast of Devon and Cornwall, more especially Dartmouth, Fowey, and Falmouth. Outside the harbour proper there is a large area more or less sheltered on the east and west by high land, but fully exposed to the south. This area is bounded on the seaward side by a bar of sand, stretching from the eastern to the western land and covered only by a few feet of water at low tide, and on the harbour side converges to a narrow mouth, which forms the entrance to Salcombe Harbour proper. Inside the mouth, the harbour widens considerably, and its general direction turns somewhat to the eastward, so that its waters become more sheltered from the southerly weather. At its north-eastern end are two large but shallow creeks, which at low tide become large mud-flats, with only a small stream running through each—Batson Lake and Southpool Lake—as well as the narrow entrance to the Kingsbridge estuary between Pilworthy Point and Snape's Point.

The Kingsbridge estuary, as is usual in these cases, has a deep winding channel, which is bounded on either side by large mud-banks covered with water only at high tide. A number of creeks with similar extensive mud-banks run into the main estuary, and there is situated at some distance from its mouth an island known as the Salstone, which at high tide is quite submerged.

The Nature of the Water.—Compared with the size of the whole estuary and the volume of sea-water which enters with the tide, the various streams which run into it are small, and the amount of fresh water which enters the estuary is not sufficient to seriously reduce the density. In Salcombe Harbour proper, and probably in the Kingsbridge estuary as far up as the Salstone, the density of the water, excepting in times of flood, is very nearly that of Channel water. The following observations of density were made by Mr. Garstang from the *Dawn*, which was moored off Ditch End, at the north-east end of Salcombe Harbour:—

Aug. 7th, 1900 (low water 8.30 p.m., 12 ft. 7 in. tide), 7.45 p.m.; temperature of water, 17° C.; density at that temperature, 1·026.

Aug. 8th, 1900 (high water at 3.12 p.m.), 2.30 p.m.; temperature of water, 15·6° C.; density, 1·0267 at 16° C.

A third determination was made by Mr. Todd between Garston Point and the Salstone in the upper part of the Kingsbridge estuary, and gave the following:—

Oct. 10th, 1900 (low water 12.49 p.m., 16 ft. 8 in. tide), 12.45 p.m.; temperature of water, 15·7° C.; density at that temperature, 1·0266.

Temperature.—Owing to the extensive area of the mud-flats, which are covered by the rising tide with a shallow layer of water, the water in the estuary must necessarily be subjected to considerable changes in temperature, which will vary in direction and magnitude according to the season of the year. To these changes of temperature, which will often be very sudden, the animals living in the estuary must of necessity be adapted.

The Movements of the Water. 1. *The Tides.*—The tidal current in Salcombe Harbour is exceedingly strong, and the scour, especially at spring tides, is very considerable in the centre of the stream. The maximum rise and fall is about 17 ft.

2. *Wave-Action.*—This is only of importance in the lower part of the harbour near the mouth, and in the area between the mouth and the bar. In the latter region it is of course a very powerful factor, and, as will be seen when the fauna of this part is treated, renders it very barren. Inside the harbour itself there is very good shelter, the effect of which upon the fauna is very marked. There is reason to suppose that the eastern shore is less disturbed than the western in this part.

Nature of the Bottom-Deposits.—The bottom-deposits will be described in detail when the separate parts of the estuary are considered. Making a general statement, we may say that in the Kingsbridge estuary the soil on the banks consists of fine, sticky mud, over by far the greater part of the area exposed at low tide. On certain parts of the shore, which are exposed to the action of specially strong tidal currents, the mud is not able to deposit to such an extent as it does on the ordinary mud-banks, and we then find a harder deposit, consisting of gravel, mixed with a considerable quantity of mud, but lying often very close to the bed-rock. At the north end of Salcombe Harbour the mud of the banks becomes mixed with considerable quantities of sand, and has a much firmer consistency, the firmness of its surface being increased by the fact that it is overgrown with zostera, the roots of which help to keep it compact. In the lower parts of Salcombe Harbour the shore consists chiefly of fine sand, excepting at the upper tidal levels where gravel and muddy gravel are found.

The nature of the deposit in the channel is only known to us from the results obtained by dredging with an ordinary dredge with net bag, no actual samples of the deposit having been taken. In the Kingsbridge estuary the dredge brought up a mass of decaying seaweeds, with a good many stones, some gravel, and a quantity of black, sticky mud. Around Snape's Point, where the Kingsbridge estuary narrows and joins Salcombe Harbour, the bottom-deposit consists of clean, fine shell-gravel, and this shell-gravel extends into the first bight on the west shore of the Kingsbridge estuary, which is known as "The Bag."

In the channel in Salcombe Harbour the dredge material consisted of stones and shells, accompanied by very little mud such as was found in the Kingsbridge estuary. In the lower part of the harbour, between Salcombe town and the mouth, a patch of *Melobesia* ground was found. Outside the mouth of the harbour the deposit is all fine, clean sand.

III. Description of the Fauna found in different parts of the Salcombe Estuary.

1. THE SALSTONE.

[Shore collecting: July 13th, 1900, tide 15 ft.; July 30th, 1900, tide 14 ft. 5 in.; August 12th, 1900, tide 16 ft.; October 10th, 1900, tide 16 ft. 8 in.]

The Salstone (see Chart) lies some distance up the Kingsbridge estuary, at the mouth of Frogmore Creek, and is distant about 2 miles from the Blackstone, which guards the entrance to Salcombe Harbour proper. It is completely covered for a short time at high tide, but is generally to be seen as an island standing almost in the middle of the estuary. The main channel of the Kingsbridge river passes close to its western side, whilst the water from Frogmore Creek passes down the south-east shore. These two shores, the western and south-eastern, from half-tide mark to low water, have a soil composed of hard muddy gravel, which only covers the underlying shale with a layer a foot or eighteen inches deep. At the southern end of the Salstone there is a small stretch of clean, coarse sand uncovered at extreme low water (16 ft. 8 in. tide).

The north-east shore, which is sheltered from the main tidal streams, is on the other hand covered with soft, sticky mud, so soft that one can only walk on it with very considerable difficulty.

On the muddy gravel of the western and south-eastern shores the common and characteristic animals are:—

(1) FIXED SPECIES. *Morchellium argus*, which is present on the muddy gravel in exceptional abundance; the orange-coloured sponge, *Hymeniacidon sanguineum*, also very common; *Sagartia bellis*, numerous in patches where a layer of mud lies on the top of a layer of gravel; *Myxicola infundibulum*, whose gelatinous tubes are very frequent, especially at the lowest tidal levels; *Branchiomma vesiculosum*, the tubes of which occur fixed often in clusters in the muddy gravel, but are confined almost entirely to the tidal level which is only just uncovered at a 15 ft. tide; *Sabella pavonina*, which on the south-east shore is found in bunches of twenty or thirty together at a lower tidal level than the *Branchiomma*, namely that just exposed at a 16 ft. tide; *Clavelina lepadiformis*, frequently attached to some of the larger stones, especially on the western shore; and *Melinna adriatica*, which is often met with in muddy patches, though it cannot be called plentiful and must be regarded as an immigrant from the adjoining fine mud.

(2) Burrowing Species. *Nephthys Hombergii* is perhaps the most commonly taken; *Amphitrite Johnstoni* is generally distributed, but is especially abundant on the south-east shore; *Nereis cultrifera* is common at the higher tidal levels; *Nereis longissima* is occasionally found in patches of finer mud. *Carinella annulata,* a few small *Notomastus latericius,* and the mollusc *Tapes pullastra* are all met with.

(3) Wandering Species. Small *Carcinus maenas* and small *Eupagurus Bernhardus* are numerous, whilst *Cardium edule* and *Prostheceræus vittatus* are also found.

Comparing the two shores the most striking differences are the special abundance of *Branchiomma vesiculosum, Sabella pavonina,* and *Amphitrite Johnstoni* on the south-east, and of *Clavelina lepadiformis, Ascidiella aspersa,* and *Phallusia mammillata* on the west. On the western shore, also, the following species were taken which did not occur on the south-eastern: *Chætopterus variopedatus, Modiola modiolus, Maclovia gigantea,* and *Lumbriconereis Latreillii.*

Three specimens of the common octopus, *O. vulgaris,* were found nested on the shore near low-tide mark (16 ft. tide), at the southern corner of the island (see Garstang, "The Plague of Octopus on the South Coast, and its Effect on the Crab and Lobster Fisheries," in the present number of this Journal, p. 260).

The fauna of the soft mud on the north-east shore of the Salstone resembles that found on this kind of mud in other parts of the estuary. Where the mud is finest the common and characteristic species is the small Sabellid *Melinna adriatica,* the tubes of which are seen protruding thickly from the whole surface of the mud-flat. The only other species which is at all frequent is the Capitellid, *Notomastus latericeus,* the specimens of which here attain a large size. These worms live in vertical, spiral burrows in the mud, which are lined with mucus. On the intermediate ground, between the finest mud and the harder muddy gravel, a number of other species occur in addition to those just mentioned, the most important of which are *Morchellum argus, Sagartia bellis, Myxicola infundibulum, Tapes pullastra,* and *Cardium edule.* At the higher tidal levels *Audouinia tentaculata* is common.

Salstone, West Shore. List of Species.

PORIFERA.

Hymeniacidon sanguineum. Common in patches of considerable size.

Suberites domuncula. Not uncommon, occupied by *Eupagurus cuanensis.*

ACTINOZOA.

Sagartia bellis. Very common in places, attached to stones generally some inches beneath the surface of the mud.

ECHINODERMA.

Asterias glacialis. One very large one on the south end of the island.

Ophrothrix fragilis. One.

TURBELLARIA.

Prostheceræus vittatus. Two found near low-water mark (16 ft. tide), in neighbourhood of *Morchellium.*

NEMERTINA.

Carinella superba. Several in the muddy gravel.

„ polymorpha. One found in similar ground.

GEPHYREA.

Phascolosoma pellucidum. Not uncommon in muddy gravel.

POLYCHÆTA.

Gattyana cirrosa. In the tubes of *Amphitrite Johnstoni.*

Sthenelais boa. Several. Elytra brown.

Maclovia iricolor. One only taken, about 18 inches long.

Lumbriconereis Latreillii. Two.

Nereis cultrifera. Plentiful.

„ longissima. In the finest mud or sand.

Nephthys Hombergii.

Audouinia tentaculata. Common in muddy gravel, especially at the higher tidal levels.

Notomastus latericeus. Several.

Arenicola marina. Common in places.

„ Grubii. One only taken.

Chætopterus variopedatus. Two or three at dead low water (16 ft. tide).

Amphitrite Johnstoni. Several.

Sabella pavonina. Not very common.

Branchiomma vesiculosum. Several.

Myxicola infundibulum. Common near low-water mark.

CRUSTACEA.

Inachus dorynchus. A few.

Gebia stellata. One specimen.

Eupagurus Bernhardus. Young ones common near and below low-water mark, generally in *Littorina* shells.

MOLLUSCA.

Solen ensis. Shells only.

Lutraria elliptica. Shells only.

Tapes pullastra. Very common; found on or close under the surface, or buried to a depth of several inches.

Cardium edule. Common, near to or upon the surface.

Modiola modiolus. One living animal taken attached to a stone.

Pinna pectinata. Shells only taken.

Fissurella reticulata. One only taken.

Trochus zizyphinus. Common at lower tidal levels.

„ cinerarius. Common.

„ umbilicaris.

Littorina littoralis. }
„ littorea. } Common at higher levels, on Fucus.

Scalaria communis. One on the gravel at the south end.

Bulla hydatis. Five were found on the surface of the muddy gravel on the west shore, and seven or eight on a patch of coarse sand at the extreme south.

Octopus vulgaris. Three found in holes between rocks covered with stones and shells.

TUNICATA.

Botryllus violaceus. Only a few small pieces seen.

Ascidiella aspersa. Very common and large, either attached to stones or lying free upon the surface.

Phallusia mammillata. Several found.

Clavelina lepadiformis. Very common, attached to stones.

Didemnum sp. Not uncommon.

Amaroucium Nordmanni. Found along with *Morchellium argus*, but much less numerous.

Morchellium argus. Very common.

PISCES.

Centronotus gunnellus. One found on the south end, inside an empty *Buccinum* shell.

Salstone, South-East Shore. List of Species.

FORAMINIFERA.

A sample of sand taken on the south-east shore, just above low water (16 ft. tide), was found to contain 78 Foraminifera in 13 c.grms. All were identified.

Rotalia beccarii	77 per cent.
Polystomella crispa (a few specimens of P. striato-punctata included)	18 „
Miliolina seminulum	3 „
Truncatulina lobatula	1 „
Bolivina dilatata	1 „

Miliolina bicornis, M. agglutinans, Nonionina depressula, Textularia gramen, and T. agglutinans were also present. Some of the specimens of *Rotalia beccarii* are of very considerable dimensions. Nearly all are large. [R. H. WORTH.]

PORIFERA.

Hymeniacidon sanguineum. Very abundant.

Suberites domuncula.

HYDROZOA.

Hydractinia echinata. On shell inhabited by *Eupagurus Bernhardus*.

ACTINOZOA.

Sagartia bellis. Extremely abundant in places.

„ parasitica. On shell inhabited by *Eupagurus Bernhardus*.

ECHINODERMA.

Amphiura elegans. One or two.

Ophiothrix fragilis. One or two.

NEMERTINA.

Carinella superba. Two large specimens in muddy gravel.

TURBELLARIA.

Prostheceræus vittatus. Three at low-water level (16 ft. tide) in the neighbourhood of *Morchellium.*

GEPHYREA.

Phascolosoma pellucidum. One in very soft shale, almost clay.

POLYCHÆTA.

Gattyana cirrosa. In tubes of *Amphitrite Johnstoni.*

Sthenelais boa. Brown elytra.

Marphysa Bellii. One or two.

Nereis cultrifera. Numerous at same level as *Branchiomma*, occasionally lower down.

„ longissima. Two in muddy sand.

Nephthys Hombergii. Moderately common.

Audouinia tentaculata. Common at higher tidal levels.

Magelona papillicornis. One specimen.

Notomastus latericeus. Not very large, but moderately common.

Clymene sp. Occasional specimens.

Amphitrite Johnstoni. Fairly common.

Melinna adriatica. Occasionally found everywhere.

Sabella pavonina. Very abundant in places, at a lower tidal level than *Branchiomma.* Sometimes twenty to thirty tubes in a cluster at low-water mark, 16 ft. tide.

Branchiomma vesiculosum. Common in patches, often in clusters of six to twelve tubes, chiefly at low-water mark, 15 ft. tide.

Myxicola infundibulum. Common.

CRUSTACEA.

Inachus dorynchus.

Carcinus mænas. Fairly common.

Eupagurus Bernhardus. Young ones were very common, chiefly in *Littorina* shells. One large one at low-water level (16 ft. tide) with *Sagartia parasitica.*

MOLLUSCA.

Lutraria elliptica. One, eight or nine inches below the surface, in gravel.

Tapes pullastra. Several near or at the surface or several inches below.

Cardium edule. Occasionally found near or on the surface.

Pecten opercularis. One or two lying on the surface of the gravel.

Scalaria communis. Four found at low-water level, 16 ft. tide.

Bulla hydatis. One.

Archidoris tuberculata. Two large ones near low-water level (16 ft. tide) in the neighbourhood of *Morchellium* and *Hymeniacidon.*

TUNICATA.

Ascidiella aspersa. A few.

Phallusia mammillata. One.

Clavelina lepadiformis. A few colonies on stones.

Morchellium argus. Very common, attached to the gravel.

Salstone, North-East Mud (harder parts). List of Species.

PORIFERA.

Hymeniacidon sanguineum. Common where suitable stones for its attachment are found.

ACTINOZOA.

Sagartia bellis. Common in places where stones suitable for its attachment lie at some distance (from one to four or five inches) below the surface of the mud.

POLYCHÆTA.

Nereis longissima. A few in fine mud.
Audouinia tentaculata. Common at higher tidal levels.
Notomastus latericeus. Very common and large.
Clymene sp. A number of specimens.
Chætopterus variopedatus. One.
Melinna adriatica. Common ; exceedingly abundant in the finest mud.
Myxicola infundibulum. Common.

CRUSTACEA.

Carcinus mænas.

MOLLUSCA.

Lutraria elliptica. One.
Tapes pullastra. Common.
Cardium edule. Common at or near the surface of the mud.
Aplysia punctata. Only one seen.

TUNICATA.

Ascidiella aspersa. Only one or two seen.
Morchellium argus. Common where stones are present.

Salstone, North-East Mud (finest parts). List of Species.

POLYCHÆTA.

Myrianida maculata. One, budding. In the finest mud.
Notomastus latericeus. Large and numerous.
Melinna adriatica. Extremely numerous.

2. MUD-FLAT BETWEEN GARSTON POINT AND THE SALSTONE, ON THE WESTERN SIDE OF THE KINGSBRIDGE ESTUARY.

[Shore collecting : August 29th, 1900, tide 14 ft. 5 in.]

Near low-water mark the sloping edge of the bank was composed of stiff clayey mud, in which a characteristic fauna was found, consisting of a small number of species, most of which, however, were present in considerable abundance.

POLYCHÆTA.

Nereis cultrifera. By no means so plentiful as *N. longissima.*
,, longissima. Six specimens.
Nephthys Hombergii. Common.

Notomastus latericeus. Common.

Clymene sp. A species of *Clymene*, at present undetermined, was plentiful.

Melinna adriatica. Extremely abundant.

Sabella pavonina. Common in clusters.

Branchiomma vesiculosum. Several.

MOLLUSCA.

Pholas dactylus. A number of large recent dead shells, together with lumps of bored chalk, were found just under the surface of the mud.

Tapes pullastra. Two or three living specimens.

3. HALWELL POINT TO PILWORTHY POINT.

A large flat of very fine, sticky mud occupies the greater part of the bay on the eastern side of the Kingsbridge estuary, immediately south of Halwell Point, excepting on the southern shore, under the lime kiln (see Chart), where the ground becomes harder, a good deal of gravel being mixed with the mud. The mud-flat was examined at its southern end only, and those species which are usually found in the softest mud were discovered. The tubes of *Melinna adriatica* were extremely abundant, and the Capitellid *Notomastus latericeus* was not uncommon, large specimens being obtained occupying their usual spiral burrows.

The fauna on the southern shore of the bay, where the ground consisted of very muddy gravel, resembled that found on those parts of the Salstone where the ground was of a similar nature. The most noteworthy feature is perhaps the abundance of *Nereis longissima* in the more muddy parts.

Shoreunder Limekiln opposite Tosnos Point. List of Species.

[Shore collecting: August 15th, 1900, tide 15 ft. 7 in. Gravel with a large amount of mud.]

PORIFERA.

Hymeniacidon sanguineum.

ACTINOZOA.

Sagartia bellis. Common in patches.

POLYCHÆTA.

Gattyana cirrosa. In tubes of *Amphitrite Johnstoni.*

Lumbriconereis Latreillii. Two specimens.

Nereis cultrifera. Plentiful.

" longissima. Eight specimens.

Nereis irrorata. One only.

" diversicolor. One only.

Nephthys Hombergii. Several.

Audouinia tentaculata. At higher tidal levels.

Notomastus latericeus. Common.

Amphitrite Johnstoni. With *Gattyana cirrosa.*
Lanice conchilega. A few.
Melinna adriatica. Common.
Branchiomma vesiculosum. Common in patches.
Myxicola infundibulum. Fairly common.

MOLLUSCA.

Tapes pullastra. Several.
Cypræa europæa. Several.

TUNICATA.

Morchellium argus. Common.

Melinna adriatica was extremely abundant in the fine mud to the north of the gravel, and *Notomastus latericeus* was also found living there.

North of Pilworthy Point.

The shores of the bay immediately north of Pilworthy Point were only examined at a 13 ft. 4 in. tide, so that the results refer to a somewhat high tidal level.

Immediately north of the Point very fine mud was found, in which, as usual, *Melinna adriatica* was very abundant. There were also a few *Arenicola marina,* and young *Crangon vulgaris* were extremely numerous in the shallow pools left in hollows of the mud.

In the more gravelly portions at a higher tidal level the following species were found:—

List of Species.

ACTINOZOA.

Sagartia bellis. Fairly common everywhere, in places very numerous.

POLYCHÆTA.

Harmothoë lunulata.
Nereis cultrifera. Common.
„ diversicolor. Several.
Nephthys Hombergii. Common.
Audouinia tentaculata. Common in patches of black muddy gravel, accompanied only by *Nereis cultrifera.*
Notomastus latericeus.
Arenicola marina. Common.

CRUSTACEA.

Carcinus mænas. Small, abundant.

MOLLUSCA.

Scrobicularia piperata. Eight, in gravel.
Tapes decussata.
Cardium edule. One or two lying on the surface.

At the north end of the bay, 40–50 yards south of the first reef of rocks, where the shore consisted of stiff clay gravel, lying on hard clay, underneath which was soft rock, the following were found, the noteworthy feature being the abundance of very large specimens of *Phascolosoma* :—

GEPHYREA.

Phascolosoma vulgare. Large specimens very abundant in a patch of gravel measuring 10 yards by 3 yards.

POLYCHÆTA.

Nereis cultrifera. Several.	Arenicola marina. Occasional.

POLYZOA.

Loxosoma phascolosomatum. Common, attached to the hinder end of nearly all the specimens of *Phascolosoma*.

4. ZOSTERA BANKS AT THE NORTH-EASTERN END OF SALCOMBE HARBOUR.

The shores exposed at low water at the north-eastern end of Salcombe Harbour consist chiefly of banks of fairly hard muddy sand covered with zostera. Near low-water mark there are generally patches of finer and softer mud from which the zostera is absent. Three of these banks were examined carefully, but the fauna on all three is so similar that they may be treated together. These banks are (1) the zostera bank between Snape's Point and Salcombe town; (2) the zostera bank south of Pilworthy Point at the junction of the Kingsbridge estuary and Southpool Lake; (3) the zostera bank between Ditch End and Southpool Lake, on the south-east shore.

In the following list the comparative abundance of each species on the different banks is indicated.

List of Species obtained by Shore Collecting.

1. August 1st, 1900, tide 13 ft. 6 in.
2. June 19th, 1900, tide 13 ft. 9 in
3. June 16th, 1900, tide 14 ft. 10 in.; July 15th, 1900, tide 15 ft. 6 in.

FORAMINIFERA.

A sample from the surface of the zostera bed south of Pilworthy Point consisted of a very fine sand with extremely small particles mixed with it. Thirty-five Foraminifera were found in 13 c.grms. Of these seven were not identified, but all were probably species as under. Of those identified :—

Rotalia beccarii	42	per cent.
Polystomella crispa	28	,,
Textularia agglutinans	14	,,
Nonionina depressula	4	,,
Lagena striata	4	,,
Truncatulina lobatula	4	,,
Miliolina seminulum	4	,,

The following species, in addition to the above, were also identified: Miliolina bicornis, Haplophragmium canariense, Textularia saggitula, Bulimina pupoides, Bolivina punctata, Lagena sulcata, Lagena orbignyana, Planorbulina mediterranensis.

[R. H. W.]

ACTINOZOA.

Sagartia bellis. Common on banks (1) and (2).

GEPHYREA.

Phascolosoma pellucidum. One (3).

NEMERTINA.

Carinella superba. One large specimen (3).

POLYCHÆTA.

Marphysa sanguinea. One specimen (3).
Lumbriconereis Latreillii (3).
Nereis cultrifera. Eight (1); several (2); common (3).
„ longissima. Two small ones (1); one (2); two (3).
„ diversicolor. Three (1).
Nephthys Hombergii. Several (1); several young ones in muddy gravel inshore (2).
Glycera convoluta (1).
Audouinia tentaculata. Common in patches of black mud (1); common in patches (3).
Notomastus latericeus. A few (1); several in muddy gravel (2); several (3).
Arenicola marina. Common (1); common in muddy gravel (2); common in muddy gravel (3).
Clymene sp. Occasional specimens in (1).
Amphitrite Johnstoni. Two from gravel (3).
Lanice conchilega. Small one (3).
Melinna adriatica. Very common in mud free from zostera (1); common in mud free from zostera (2); occasionally on zostera bank (3).
Pectinaria belgica. One on gravel at higher tidal level (3).
Sabella pavonina. Several (3).
Branchiomma vesiculosum. Several (1), (2), and (3).
Myxicola infundibulum. Several (1) and (2); very common, especially at dead low water (3).

CRUSTACEA.

Carcinus mænas. Common, living in holes (1) (2) (3); most common in (3).
Gebia stellata. Two (1), one with ova.
Corophium grossipes. Very common in mud free from zostera, living in vertical burrows 4–5 inches long (3).

MOLLUSCA.

Tellina solidula. One in gravel near shore (3).
Scrobicularia piperata. Six in zostera-free mud (1).
Tapes pullastra. Several (1).
Cardium edule. Several (2); one (3).
Mytilus edulis. One attached to a stone (1).
Nassa reticulata. Spawn on zostera (3).
Æolis papillosa. One (3).

TUNICATA.

Ascidiella aspersa. A few (3).
Morchellium argus. A few specimens attached to stones in the mud (3).

List of Specimens obtained with Cheese-cloth Trawl.

[The cheese-cloth trawl was worked on the same three banks at high tide, viz.:—
(1) Between Snape's Point and Salcombe town (August 2nd, 1900);
(2) South of Pilworthy Point (July 6th, 1900); and
(3) Between Ditch End and Southpool Lake (July 7th, 1900).]

ECHINODERMA.

Amphiura elegans. One (3).

CRUSTACEA.

Carcinus mænas. Common (2) and (3); one or two (1).
Crangon vulgaris. A few (1) and (3); common but small (2).
Hippolyte varians. A few (3).
Palæmon serratus. A few (2) and (3); one small one (1).
Macromysis flexuosa. (1); very common on (2); two dozen (3).
Macromysis neglecta (?). (2) and (3).
Idothea balthica. Several (2) and (3); one (1).
Arcturus gracilis. One (3).
Jæra marina. One or two (3).
Ampelisca typica. One (3).
Dexamine spinosa. A few (3).
Gammarus locusta. Common (1), (2), and (3).
Corophium grossipes. Two (1); several (3).
Phthisica marina. Several (3).

MOLLUSCA.

Venus ovata. One (1).
Littorina littorea. Several small (2).
Rissoa labiosa. Very common (1); a few (2) and (3).
Rissoa ulvæ. Several (1); common (2); one (3).
Cerithium reticulatum. One (2).
Chemnitzia elegantissima. Shell only (1); very common (2).
Nassa reticulata. One (1).
Elysia viridis. One (3).

PISCES.

Cottus sp. One (2).
Gobius Ruthensparri. One young (3); numerous young at all stages and adults (2).
Callionymus lyra. One, ¾ inch long (3).
Gasterosteus spinachius. (2) and (3).

5. SOUTHPOOL LAKE.

[Shore collecting: July 15th, 1900, tide 15 ft. 6 in.]

The large mud-flats laid bare at low tide in Southpool Lake are composed of the finest sticky mud, so soft that one sinks nearly to the knees when walking upon it. The mud is very barren, the small Sabellid *Melinna adriatica* being the only abundant animal living in it. In the inlet just below the Rectory, on the southern shore, down which a stream of fresh water runs, there is some slightly harder ground, in which a number of species were found, as listed below.

List of Species.

ACTINOZOA.

Sagartia bellis. Fairly common where the mud contains suitable stones for its attachment.

POLYCHÆTA.

Marphysa sanguinea. Occasional specimens.
Nereis cultrifera. Occasional specimens.
„ diversicolor. The commonest Nereid on this shore.
Nephthys Hombergii. Occasional specimens.
Audouinia tentaculata. Common in places.
Arenicola marina. Common.
Melinna adriatica. Very common in the finest mud.

CRUSTACEA.

Carcinus mænas. Small, common.
Crangon vulgaris. Young common in pools in the mud.
Schistomysis Helleri. In the pools on the mud, not uncommon.

MOLLUSCA.

Scrobicularia piperata. One found in muddy gravel.
Tapes decussata. One or two in muddy gravel.

6. EAST SIDE OF SALCOMBE HARBOUR (DITCH END TO FERRY HOUSE).

[Shore collecting: August 14th, 1900, tide 16 ft.]

This shore was examined on one occasion only, and then not very thoroughly. The northern half of it is composed of gravel and stones mixed with a little mud, in which digging is difficult. In this hard ground the following species were taken:—

GEPHYREA.

Phascolosoma vulgare. Common in a patch of gravel at a high tidal level.
„ pellucidum. A few.

POLYCHÆTA.

Nereis irrorata. One.
Branchiomma vesiculosum. Common in patches at same level as *Phascolosoma vulgare*.

Further south sandy mud, covered in patches with zostera, was found. Species taken here were:—

ACTINOZOA.

Sagartia bellis. Not uncommon in places.

POLYCHÆTA.

Harmothoë setosissima. One.
Nephthys Hombergii.
Glycera convoluta.
Goniada maculata. One specimen.
Notomastus latericeus. Fairly common.
Melinna adriatica. A few.
Myxicola infundibulum. One or two.

CRUSTACEA.

Gebia stellata. Burrows of *Gebia* are common in patches of muddy sand free from zostera.

7. SAND BANKS AND ZOSTERA BEDS NEAR THE MOUTH OF SALCOMBE HARBOUR.

The conditions prevailing on the shores on either side of Salcombe Harbour, between Salcombe town and the harbour mouth, are very similar. The deposits exposed at spring tides consist chiefly of fine sand and sandy mud, which is covered with large patches of zostera. On the west (town side) there is a band of muddy gravel at a higher tidal level than the zostera, and this gravel possesses a somewhat different fauna from that found on the sandbanks.

Comparing the animals found on the two sides of this part of the harbour, we notice that the eastern side has, on the whole, a richer fauna than the western. *Echinocardium cordatum*, which is very common on zostera-free patches on the eastern side, is altogether absent on the western. *Solen marginatus*, common on the eastern side, is practically absent on the western, as are also *Ophiocnida brachiata* and *Gebia stellata*, both of which are common on the eastern zostera banks near low-water mark. The following species also, found on the eastern shore, are much less plentiful or altogether wanting on the western: *Myxicola infundibulum*, *Sthenelais boa*, *Lucina flexuosa*, *Lucina borealis*, *Lutraria elliptica*, *Cardium edule*, and *Montacuta ferruginosa*, which is commensal with *Echinocardium cordatum*.

On the other hand, the following occur much more frequently on the western than on the eastern side: *Cerianthus*, *Nereis irrorata* (on the coarser gravel at the higher tidal levels), *Amphitrite Edwardsi* and *Amphitrite Johnstoni* (with their respective commensal polynoids *Lepidasthenia argus* and *Gattyana cirrosa*), *Pecten maximus* and *Aplysia punctata*. The difference in distribution in the case of the two latter, which are wandering species, may be due to the fact that whereas on the eastern shore the edges of the banks are steep and the deep channel is close to them, on the western side the banks slope more gradually into the deep water.

The greater prevalence of burrowing species on the eastern than on the western shore may in a measure be due to the fact that the former is somewhat more sheltered from the effects of southerly gales than the latter.

COMPARISON OF THE FAUNA FOUND ON THE SHORE AT THE SALSTONE WITH THAT FOUND NEAR THE MOUTH OF SALCOMBE HARBOUR.—The following species are abundant on the shore between Salcombe town and the mouth of the harbour on the eastern or western side, but are either not found or are much less numerous on the Salstone:—

Ophiocnida brachiata.
Echinocardium cordatum, with Montacuta ferruginosa.
Synapta inhærens.
Nephthys cæca.
Goniada maculata.
Amphitrite Edwardsi, with Lepidasthenia argus.
Lanice conchilega.
Gebia stellata.
Solen marginatus.
Pecten maximus.
Venus striatula.
Lucina borealis.
Aplysia punctata.

On the other hand, certain species are abundant on the shore at the Salstone which are absent or are much less numerous on the banks near the mouth of Salcombe Harbour. Amongst these are:—

Hymeniacidon sanguineum.
Sagartia bellis.
Prostheceræus vittatus.
Nereis longissima.
Notomastus latericeus.
Branchiomma vesiculosum.
Myxicola infundibulum.
Sabella pavonina.
Melinna adriatica.
Inachus dorynchus.
Tapes pullastra.
Scalaria communis.
Bulla hydatis.
Phallusia mammillata.
Ascidiella aspersa.
Morchellium argus.

Amongst the Foraminifera *Rotalia beccarii* is the prevailing species on the Salstone, whilst its place seems to be taken by *Polystomella crispa* and *Truncatulina lobatula* on the zostera banks and sand near the mouth of the harbour.*

On comparing the two lists just given, it will be seen that the majority of the species are animals which adopt either the fixed or burrowing habit, and the nature of the soil or bottom-deposit will in many cases be the determining factor in the difference of distribution observed. In the lower parts of the harbour this is almost entirely fine sand, whilst on the Salstone it is either muddy gravel or fine mud The increased amount of wave-action near the mouth of the harbour is also a factor which must be taken into consideration, though its action is doubtless principally indirect in preventing the deposition of mud.

As has been pointed out elsewhere, it seems probable that the difference in the density of the water in the two localities is not very great, and that even at the Salstone we are still dealing with a marine rather than with a brackish-water fauna. The amount of suspended mud in the water, on the other hand, will be very much greater in the higher part of the estuary.

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* *Polystomella crispa* is very abundant on the zostera in Cawsand Bay, near Plymouth, and can be obtained in quantity by rubbing the zostera on a sieve, a mode of obtaining it which is due to Mr. J. J. Lister. [E. J. A.]

Western Shore. Salcombe Town to Gazebo (under Marine Hotel).

[Shore collecting: June 15th, 1900, tide 14 ft. 10 in.; August 11th, 1900, tide 15 ft. 4 in.; August 25th, 1900, tide 14 ft. 6 in.; August 27th, 1900, tide 14 ft. 11 in.; October 9th, 1900, tide 16 ft. 6 in.; October 11th, 1900, tide 16 ft. 4 in.]

List of Species.

ACTINOZOA.

Sagartia bellis. Not uncommon, but not in the profusion found in the Kingsbridge estuary.

Cerianthus sp. General in the zostera banks.

ECHINODERMA.

Synapta inhærens. Not uncommon in the zostera banks.

Ophiocnida brachiata. One in the zostera banks.

NEMERTINA.

Lineus bilineatus. One.

GEPHYREA.

Phascolosoma pellucidum. Fairly common in the zostera banks.

POLYCHÆTA.

Lepidonotus squamatus. One on zostera bank.

Gattyana cirrosa. Common; commensal in tubes of *Amphitrite Johnstoni.*

Lepidasthenia argus. Not uncommon; commensal in the tubes of *Amphitrite Edwardsi.*

Marphysa Bellii. One specimen found.

Maclovia iricolor. One.

Lumbriconereis Latreillii. Common in zostera banks.

Nereis cultrifera. Very common; several in Heteronereis condition, June 15th and August 11th.

,, longissima. One or two each day.

,, irrorata. Moderately common in the gravel above the zostera beds. Heteronereis stage, October 11th.

Nephthys Hombergii.

,, cæca.

Glycera convoluta. One small one only found.

Goniada maculata. Three specimens.

Audouinia tentaculata. Plentiful in muddy sand and gravel at higher tidal levels.

Spio seticornis. Very common in the gravel at higher tidal levels.

Nerine cirratulus. One.

Scoloplos armiger. One or two.

Notomastus latericeus. Moderately plentiful in zostera banks.

Arenicola marina. Common.

Clymene sp. Two species, at present undetermined, were not uncommon.

Chætopterus variopedatus. One in zostera bank.

Amphitrite Edwardsi. Not uncommon at a slightly higher tidal level than *A. Johnstoni.*

,, Johnstoni. Moderately common.

Lanice conchilega. Abundant on sand below Gazebo.

Melinna adriatica. Not uncommon in zostera banks.

CRUSTACEA.

Carcinus mænas. A few.

Gebia stellata. Two in zostera bank.

MOLLUSCA.

Solen marginatus. One small one in zostera bank.

Tellina fabula. One in zostera bank.

Scrobicularia piperata. One in gravel at higher tidal level.

Lutraria elliptica. Two or three in sand free from zostera.

Venus striatula. Two or three on surface of sand free from zostera.

Lucina borealis. Several in zostera bank, 5 to 6 inches below the surface.

Pecten maximus. Not uncommon, lying on the zostera.

Trochus striatus. Very common on the zostera.

Rissoa labiosa. Very common on the zostera.

Aplysia punctata. Extremely abundant with spawn on June 15th, 1900, lying on the zostera. Much less common on our later visits.

TUNICATA.

Morchellium argus. An occasional piece among the zostera.

Zostera under the Marine Hotel. Cheese-cloth Trawl.

[July 14th, 1900.]

CRUSTACEA.

Crangon vulgaris. A few.

Palæmon serratus. Several.

Macromysis neglecta (?). Eight.

Macromysis inermis. Three.

Idothea balthica. One small.

PYCNOGONIDA.

Phoxichilus spinosus. One male.

MOLLUSCA.

Aplysia punctata. One.

PISCES.

Cottus sp. Several.

Gobius Ruthensparri. Abundant from 18–20 mm. long.

Aphia pellucida. One.

Gasterosteus spinachia. Several.

Labrus maculatus. Several small.

Crenilabrus melops. Many small ones.

Nerophis æquoreus.

Eastern Shore. Sand and Zostera Banks between the Ferry House and Millbay.

[Shore collecting: June 14th, 1900, tide 14 ft. 10 in.; July 12th, tide 14 ft. 6 in.; July 16th, tide 15 ft. 5 in.; August 10th, tide 14 ft. 7 in.; August 13th, tide 16 ft. 2 in.; August 14th, tide 16 ft.; August 25th, tide 14 ft. 6 in.; August 28th. tide 14 ft. 9 in.; October 9th, tide 16 ft. 6 in.; October 11th, tide 16 ft. 4 in.]

FORAMINIFERA.

In 13 c.grms. of a sample of the surface sand at Millbay 62 Foraminifera were counted, and all identified. These belonged to the following species:—

Nonionina depressula	29 per cent.
Truncatulina lobatula	24 „
Rotalia beccarii	16 „

Miliolina seminulum	11·5 per cent.
Polystomella crispa	6·5 ,,
Textularia gramen	5 ,,
Polystomella striato-punctata	3 ,,
Discorbina rosacea	2 ,,
Planorbulina mediterranensis	1·5 ,,
Bulimina pupoides (? Bulimina elegans) . . .	1·5 ,,

The specimens of Miliolina seminulum were generally much smaller than those found in the next sample. One large specimen of Polymorphina compressa was found; compared with the individuals from the 30-fathom line off this coast the size is striking.

On floating, the following additional species were obtained: Lagena sulcata, Lagena orbignyana.

A sample of the fine surface sand taken between the Ferry House and Millbay was found to contain 50 Foraminifera in 13 c.grms.

Of these eleven were not identified, but all were probably species as under:—

Nonionina depressula .	26 per cent.	Textularia agglutinans .	5 per cent.
Polystomella crispa .	18 ,,	Bulimina pupoides . .	2·5 ,,
Miliolina seminulum .	13 ,,	Planorbulina mediterranensis	2·5 ,,
Rotalia beccarii . .	13 ,,	Lagena orbignyana . .	2·5 ,,
Polystomella striato-punctata	7·5 ,,	Discorbina rosacea . .	2·5 ,,
Textularia gramen . .	5 ,,	Truncatulina lobatula .	2·5 ,,

Many of the individuals of Miliolina seminulum are of exceptional size.

There were also present occasional individuals of Biloculina ringens, Miliolina bicornis, and Lagena apiculata.

The following small species, in addition to those given above, were obtained by floating them from another portion of the dried sample: Bolivina punctata, Lagena striata, L. sulcata, and L. hexagona.

Another sample of very find sand or mud from near the Ferry House contained 53 Foraminifera in 13 c.grms.

Of these sixteen were not identified, but all were probably species as under.

Of those identified—

Polystomella crispa . .	24 per cent.	Truncatulina lobatula .	5·5 per cent.
Nonionina depressula .	19 ,,	Textularia agglutinans .	5·5 ,,
Miliolina seminulum .	16·5 ,,	Discorbina rosacea . .	2·5 ,,
Rotalia beccarii . .	16·5 ,,	Lagena orbignyana . .	2·5 ,,
Polystomella striato-punctata . . .	5·5 ,,	Planorbulina mediterranensis . . .	2·5 ,,

The following species were identified in addition to those given above: Bulimina pupoides, Bolivina punctata, Lagena sulcata, L. lævis, L. hexagona, Polymorphina lactea, Nonionina stelligera. [R. H. W.]

ACTINOZOA.

Sagartia bellis. Occasional specimens.

Actinia mesembryanthemum. A few scattered, generally attached to stones.

Halcampa chrysanthellum. Only one found, buried in zostera bank.

ECHINODERMA.

Synapta inhærens. Not uncommon in the zostera banks.

Ophiocnida brachiata. Common in zostera banks near low-water mark. None found in free sand.

Echinocardium cordatum. Very common in the sand between Millbay and the zostera banks. Only two or three small ones were taken in the zostera banks themselves.

NEMERTINA.

Lineus bilineatus. Common in sand with a little zostera.

Carinella superba. Not uncommon in the zostera banks.

GEPHYREA.

Phascolosoma vulgare. One specimen only.

,, pellucidum. Very common in zostera banks.

POLYCHÆTA.

Aphrodite aculeata. One only, about 1 inch long.

Lepidasthenia argus. One in Amphitrite burrow.

Sthenelais boa. Several.

Marphysa sanguinea.

Maclovia iricolor. Two or three only.

Nereis cultrifera. Not uncommon in zostera banks.

,, longissima. One or two only.

,, irrorata. One only, exact locality not recorded.

,, diversicolor. Not frequent.

,, fucata. One, probably from shell inhabited by hermit crab.

Nephthys Hombergii. Small specimens common in the fine sand free from zostera, large ones in the zostera banks.

,, cæca. A number of large specimens found.

Glycera convoluta. A few only.

Goniada maculata. Two specimens.

Magelona papillicornis. Several from Millbay sand.

Nerine conicocephala. One only found.

Scoloplos armiger. In the fine sand.

Notomastus latericeus. In the zostera bank; moderately frequent, but generally small.

Arenicola marina. Common; very large at low-water mark.

Clymene sp. Three different species were found, two of them being common.

Owenia fusiformis. Three specimens in clean, fine sand at Millbay.

Amphitrite Edwardsi. One.

Lanice conchilega. Common in sand at Millbay.

Melinna adriatica. A few in muddy sand at north end of zostera banks.

Myxicola infundibulum. A few specimens seen on the zostera bank.

CRUSTACEA.

Carcinus mænas. A few.

Gebia stellata. Common in zostera banks and in muddy sand to the north of them.

Eupagurus Bernhardus. Small ones frequent below low-water mark.

Crangon vulgaris. Common below low-water mark.

Palæmon serratus. Common amongst zostera below low-water mark.

MOLLUSCA.

Thracia phascolina. Three buried in sand at Millbay.

Solen marginatus. Very common in Millbay sands, less common in zostera banks.

„ siliqua. Several in Millbay sand.

„ pellucidus. Not uncommon in sand.

Tellina incarnata. Shells only.

„ fabula. Shells only.

Syndosmya sp. One living in clean sand.

Tapes pullastra. One only.

Lutraria elliptica. Common in sand and zostera banks, especially off Millbay.

Venus striatula. Two or three found lying on the clean sand at Millbay.

„ fasciata. Two found under same conditions.

Cardium edule. Not uncommon on Millbay sand.

Lucina borealis. Common in sand and zostera banks.

„ flexuosa. Not uncommon in sand and zostera banks.

Montacuta ferruginosa. Very common; commensal with *Echinocardium cordatum.*

Trochus zizyphinus. Several.

„ magus. Three on sand at Millbay.

Littorina littoralis. Several on zostera.

„ littorea. Several on zostera.

Natica monilifera. Shell only.

Purpura lapillus. Two or three living ones on sand.

Buccinum undatum. Shell.

Cypræa europæa. One or two.

Philine aperta. On zostera, with spawn.

Aplysia punctata. Two or three only, with spawn.

Æolis papillosa. Spawn only found.

TUNICATA.

Morchellium argus. Small pieces only.

Zostera between the Ferry House and Millbay. Cheese-cloth Trawl.

[July 12th, 1900.]

ECHINODERMA.

Amphiura elegans. One.

CRUSTACEA.

Crangon vulgaris. Few, two with ova.

Hippolyte varians. Very common.

Macromysis flexuosa. One or two only.

Idothea balthica. One.

Ampelisca typica. Two.

Dexamine spinosus. Two or three.

Gammarus locusta. Common.

„ campylops. Common.

Phthisica marina.

PYCNOGONIDA.

Phoxichilus spinosus. Two.

MOLLUSCA.

Trochus striatus. Two.

„ cinerarius. One.

Littorina littoralis. One.

Rissoa labiosa. Several.

„ ulvæ. A few.

Cerithium reticulatum. One.

PISCES.

Gobius Ruthensparri. Two or three.

Centrolabrus exoletus. One.

8. BAYS OUTSIDE SALCOMBE HARBOUR.

[July 14th, 1900.]

The following records, representing the results of only one day's collecting outside the harbour, may be added, although by no means complete.

Rocks between Gazebo and North Sands Bay.

PORIFERA.

Sycon compressum.
Halichondria panicea.

HYDROZOA.

Sertularia pumila. With gonophores; on Laminaria.

ACTINOZOA.

Anthea cereus.
Actinia mesembryanthemum.
Tealia crassicornis.

ECHINODERMA.

Cucumaria pentactes. One under stone.
Ophiothrix fragilis. Under stones.

POLYCHÆTA.

Marphysa sanguinea. One in gravel between stones.
Audouinia tentaculata. Several in gravel.

CRUSTACEA.

Porcellana platycheles. Under stones.
Hippolyte varians. In rock pools.
Palæmon serratus. In rock pools.

MOLLUSCA.

Aplysia punctata. One only.
Pleurobranchus plumula. One.

POLYZOA.

Umbonula verrucosa. On rocks and stones.

TUNICATA.

Botryllus violaceus. On rocks and stones.
Clavelina lepadiformis. On rocks and stones.
Morchellium argus. On rocks and stones.

North Sands Bay.

The clean sand of this bay, which in stormy weather is washed by a heavy sea, was found to be very barren.

POLYCHÆTA.

Arenicola marina.
Lanice conchilega.
Melinna adriatica.

South Sands Bay.

Very similar to the North Sands Bay. There is a zostera bed on the south side of the bay in which a few Polychætes were found.

POLYCHÆTA.

Nereis cultrifera. In zostera bank.
Nephthys Hombergii. In zostera bank.
Notomastus latericeus. One in zostera bank.
Arenicola marina. Very common.
Lanice conchilega. Very common.

Cheese-cloth Trawl on the Bar, Salcombe.

[August 21st, 1900.]

CRUSTACEA.

Diogenes varians. One in *Littorina* shell.
Crangon vulgaris. A few large ones.
,, trispinosus. Several.
Schistomysis arenosa. One.
Bathyporeia pelagica. Three.
Urothoë sp. Several.
Pontocrates altamarinus. Three.
Paratylus falcatus. One.
Idothea balthica. One.

MOLLUSCA.

Mactra solida. One.

9. CHANNEL WEST OF SALSTONE.

[Dredging, August 16th, 1900.]

FORAMINIFERA.

A sample of the mud was found to contain 105 Foraminifera in 13 c.grms. Of these fourteen were not identified, but all were probably species as under.

Of those identified—

Nonionina depressula	29 per cent.
Rotalia beccarii	22 ,,
Polystomella crispa	18 ,,
,, striato-punctata	7 ,,
Bolivina dilalata	5·5 ,,
Truncatulina lobatula	4·5 ,,
Bulimina pupoides	3·5 ,,
Lagena orbignyana	3·5 ,,
Miliolina seminulum	2 ,,
Lagena sulcata	1 ,,
Textularia agglutinans	1 ,,
Bolivina punctata	1 ,,
Globigerina bulloides	1 ,,

Only one specimen of *Globigerina bulloides* in the 13 c.grms. It seems out of place so far up the estuary.

All Foraminifera of larger species are represented by small specimens.

As many of the smaller Foraminifera would be overlooked in taking the census, the figures already given are not complete. Comparatively, as between sample and sample, the numbers hold good, but absolutely they should be increased to an extent not clearly ascertainable. The following small forms or small specimens were floated from another sample of the mud: Lagena sulcata, common; L. orbignyana, fairly common; Globigerina bulloides, fairly common. All other species mentioned in the census are present, and the following not so mentioned: Miliolina agglutinans, Haplophragmium canariense, Textularia saggitula, Lagena lævis, L. hexagona, L. lagenoides, L. semistriata, Spirillina vivipara, common, Planorbulina mediterranensis. [R. H. W.]

HYDROZOA.

Sertularia argentea. Small piece.
Aglaophenia tubulifera. One colony.
Plumularia setacea. Common on *Ascidiella*.

ECHINODERMA.

Asterias rubens. One.
Ophrothrix fragilis. One or two.

NEMERTINA.

Carinella sp. One.

POLYCHÆTA.

Lagisca sp.
Harmothoë spinifera.
Syllis sp.
Myrianida maculata. One.
Amblyosyllis spectabilis. One.
Nereis cultrifera. Many small specimens.
Nereis sp. Young Nereids of at least two species.
Phyllodoce sp.
Polymnia nebulosa.
Potamoceros triqueter.
Spirorbis borealis. Common.

CRUSTACEA.

Inachus dorsettensis. A few.
Eupagurus Bernhardus. A few, small.
,, cuanensis. One or two.
Anapagurus lævis. One.
Hippolyte varians. One, with ova.
Arcturus damnoniensis. One.
Janira maculosa. One.
Leucothoe spinicarpa. One.
Gammarus locusta. Two.
Amphithoe rubricata. One.
Protella phasma. Common.

MOLLUSCA.

Crenella marmorata. Several.
Anomia ephippium. Common.
Chiton asellus. One.
Calyptræa sinensis. Common.
Cerithiopsis tuberculare. One.
Odostomia culimoides.
Aplysia punctata. One, with spawn.

POLYZOA.

Crisia ramosa. One colony, with ovicells.
Mimosella gracilis. One colony.
Amathia lendigera. One colony.
Bowerbankia pustulosa (?).

TUNICATA.

Styelopsis grossularia. A few small ones on stones and shells.
Perophora Listeri. Several, growing on *Ascidiella*.
Ascidiella aspersa. Abundant.
Didemnum sp. Common, growing on *Ascidiella*.
Morchellium argus. Abundant.

10. CHANNEL BETWEEN SALSTONE AND SNAPE'S POINT.

[Dredging: August 3rd, 7th, 16th, and 25th, 1900.]

The dredge brought up a mass of decaying seaweed, with stones, gravel, and a quantity of black, sticky mud.

List of Species.

PORIFERA.

Suberites domuncula. With *Eupagurus cuanensis*.

HYDROZOA.

Hydractinia echinata. One colony.
Eudendrium ramosum. Dead stalk.
Clytia Johnstoni. Fairly common.
Halecium Beanii. Small colony, with gonophores.
Sertularella polyzonias. Small colony.
Sertularia argentea. Several colonies, attached to stones, etc.
Antennularia antennina. One colony.
Plumularia setacea. Several colonies, attached to *Ascidiella*, etc.

ACTINOZOA.

Sagartia parasitica. One on *Buccinum* shell, inhabited by *Eupagurus Bernhardus*.

ECHINODERMA.

Amphiura elegans. Not uncommon.
Ophrothrix fragilis. Not uncommon
Echinus miliaris. Fairly common.

NEMERTINA.

Carinella superba. One.
Lineus longissimus. Several.

TURBELLARIA.

Prosthiostomum sp. One.

POLYCHÆTA.

Euphrosyne foliosa. Three.
Evarne impar.
Lepidonotus squamatus.
Harmothoë spinifera.
Sthenelais boa. Two.
Syllis (Haplosyllis) hamata.
Nereis cultrifera. Many small specimens from 15–55 mm. long.
" sp. juv. Young of two species undetermined.
Phyllodoce sp.
Eulalia punctifera.
" viridis.
Glycera capitata. One small specimen.
Nerine vulgaris. One small.
Thelepus setosus.
Polycirrus caliendrum.
" aurantiacus.

CRUSTACEA.

Stenorhynchus phalangium.
Inachus dorsettensis. Several.
Eurynome aspera. Common.
Pilumnus hirtellus. One.
Portunus corrugatus. One.
" pusillus. Common.
Ebalia tuberosa. Several.
Eupagurus Bernhardus. A few, small.
" cuanensis. Several, with *Suberites*.
" Prideauxii.
Anapagurus lævis. A few.
Porcellana longicornis. Common.
Galathea squamifera. One or two.
" intermedia. Common.
Athanas nitescens. One.
Apseudes talpa. Several.
Arcturus intermedius. One or two.
" damnoniensis. Two.
Munna Kröyeri. A few.
Dexamine spinosa. Two.
Gammarus locusta. Several.
Amphithoë rubricata. Several.
Protella phasma. Common.

MOLLUSCA.

Solen ensis. Shell only.
Saxicava rugosa. One.
Syndosmya alba. Several.
Tapes pullastra. Young.
Cardium edule. A few, young.
Kellia suborbicularis. Several.
Modiola modiolus. Young, not uncommon.
Crenella marmorata. Common.
Nucula nucleus. Several.
Pecten varius. Two.
„ maximus. One or two small.
„ opercularis. Several.
Anomia ephippium. Common.
Chiton fascicularis. One or two.
„ asellus. One or two.
Calyptræa sinensis. Very common.
Fissurella reticulata. Not uncommon.
Trochus zizyphinus. Several.
„ magus. Common.
Trochus cinerarius. Common.
Rissoa ulvæ. Common.
Phasianella pullus. One.
Turritella communis. Shells only, common.
Cerithiopsis tuberculare. Several.
Scalaria communis. Shell only.
Lamellaria perspicua. One or two.
Murex erinaceus. One.
Nassa incrassata. Several.
Buccinum undatum. Several young ones.
Mangelia septangularis. One shell.
„ costata. One.
Cypræa europæa. Common.
Philine aperta. A few.
Aplysia punctata. One or two.
Goniodoris nodosa. One or two.
Lomanotus sp. Three.
Elysia viridis. A few.

POLYZOA.

Aetea truncata. A few very small colonies on shells.
Eucratea chelata. A few bits on shells and Hydroids.
Bugula turbinata. Abundant on shells. *Ascidiella*, etc.
Crisia ramosa. Several small colonies.
Bowerbankia pustulosa (?). Common.
Pedicellina cernua. On *Turritella* shell.

TUNICATA.

Molgula sp. Several.
Ascidiella aspersa. Common.
Ascidiella scabra. Common.
Morchellium argus. Several specimens.

PISCES.

Callionymus lyra. One, ¾ inch long.

11. SHELL-GRAVEL AROUND SNAPE'S POINT AND IN THE "BAG."

[Dredging: August 25th, 1900.]

The bottom-deposit consists of clean, fine shell-gravel.

List of Specimens.

PORIFERA.

Suberites domuncula.

HYDROZOA.

Sertularella Gayi.

ECHINODERMA.

Ophiura ciliaris. One.
Amphiura elegans. One or two.
Ophrothrix fragilis. One small one.
Echinus miliaris. One.

CRUSTACEA.

Anthura gracilis. One.

Gnathia maxillaris. A few.

MOLLUSCA.

Mactra solida. A dozen.

Pecten opercularis.

Emarginula reticulata. One on *Pecten* shell.

Trochus magus. Shell.

Philine aperta. One.

POLYZOA.

Bugula flabellata. Small colony.

„ turbinata. Several colonies with ovicells.

Crisia ramosa. Small colony.

TUNICATA.

Ascidiella scabra.

Molgula sp.

12. CHANNEL BETWEEN SNAPE'S POINT AND THE MOUTH OF THE HARBOUR.

[Dredging: August 2nd, 17th, and 31st, 1900.]

The dredge brought up stones and shells, with very little mud such as was found in the channel in the Kingsbridge estuary. A patch of *Melobesia* ground was met with near the mouth of the harbour.

List of Species.

PORIFERA.

Sycon sp.

Clione celata. Boring shells, etc.

Suberites domuncula. On living *Nassa reticulata.*

ACTINOZOA.

Anthea cereus. One or two.

HYDROZOA.

Clytia Johnstoni. On Hydroids, etc.

Obelia geniculata. Small colony on *Trochus magus.*

Halecium sp. On stone.

Sertularella polyzonias. Small colony with gonophores.

Sertularia argentea. One small piece on *Trochus magus.*

Plumularia setacea. Small colonies.

ECHINODERMA.

Amphiura elegans. Several.

Echinus miliaris. Several.

NEMERTINA.

Micrura fasciolata. Several.

GEPHYREA.

Phascolion strombi. One in *Turritella communis* shell.

POLYCHÆTA.

Evarne impar.

Lepidonotus squamatus.

Nereis sp. Young only, species not determined.

Lanice conchilega.

Thelepus setosus.

Sabellaria alveolata. On shells.

Potamoceros triqueter. On shells.

Spirorbis borealis.

CRUSTACEA.

Stenorhynchus phalangium. Several.
„ tenuiostris. A few.
Inachus dorsettensis. Several.
Maia squinado. One.
Portunus pusillus. A few.
„ depurator. One.
Ebalia tuberosa. A few.
Eupagurus Bernhardus. Several.
„ Prideauxii. One.
„ cuanensis. Several.
Anapagurus lævis. One.
Galathea intermedia. Several.
Crangon vulgaris. A few.
Hippolyte varians. A few.
„ Cranchii. One.
Gnathia maxillaris. Very common.
Sphæroma curtum. One.
Idothea balthica. One or two.
Arcturus damnoniensis. Three.
„ gracilis.
Janira maculosa. A few.
Dexamine spinosa. One.
Melita gladiosa. One.
Amphithoe rubricata. One or two.
Protella phasma. Not uncommon.

PYCNOGONIDA.

Nymphon gracilis. One or two.
Ammothea echinata. Several.

MOLLUSCA.

Solen ensis. Shell only.
Saxicava rugosa. One.
Syndosmya alba. Shell only.
Lutraria elliptica. One, in process of being eaten by the *Octopus*.
Venus fasciata. One.
„ ovata. One.
Cardium norvegicum. Shell only.
Diplodonta rotundata. Shell.
Lepton squamosum. Shell only.
Modiola modiolus. Young, not uncommon.
Crenella marmorata. Several.
Pectunculus glycimeris. Shells only.
Pecten opercularis. A few small ones.
Anomia ephippium. Common.
Chiton fascicularis. One.
„ asellus. A few.
Acmæa virginea. Several.
Calyptræa sinensis. Several.
Fissurella reticulata. Several.
Trochus zizyphinus. A few.
Trochus magus. Common.
„ cinerarius. Common.
„ striatus. A few.
Rissoa parva. One.
„ ulvæ. Several.
Cerithium reticulatum. One.
Murex erinàceus. Several large ones.
Nassa reticulata. One or two.
„ incrassata. A few.
Buccinum undatum. A few young ones.
Mangelia purpurea. Shell only.
Cypræa europæa. Several.
Bulla hydatis. Shell only.
Philine aperta. Several.
Aplysia punctata. Several.
Lamellidoris bilamellata. One.
Goniodoris nodosa. One.
Æolis papillosa. One.
Elysia viridis. One.
Cratena amæna. One.
Octopus vulgaris. One.

POLYZOA.

Eucratea chelata. On *Plumularia*.
Scrupocellaria scruposa. Small colony on *Trochus magus*.
Bugula flabellata. Several colonies.
„ turbinata. Common.
Crisia ramosa.
Bowerbankia pustulosa (?).
Lichenopora hispida. A few colonies.
Pedicellina cernua. On *Sertularella*.

TUNICATA.

Ascidiella aspersa. A few.
Ascidiella scabra. A few.

IV. A Complete List of the Species Identified, with an Account of their Local Distribution.

FORAMINIFERA.*

[Nomenclature: BRADY, *Challenger Report*, ix.]

The Foraminifera were identified from samples of sand and mud taken for that purpose from the surface of the shore close to low-water mark. These samples were obtained in the following localities:—(1) The south-east shore of the Salstone; (2) the zostera bank south of Pilworthy Point, at the north-east end of Salcombe Harbour; (3) from the clean, fine sand at Millbay; (4) from some clean sand between Ferry House and Millbay, near the mouth of Salcombe Harbour; (5) from some more muddy sand near the Ferry House; (6) A sample of the mud dredged in the channel west of the Salstone was also examined.

BILOCULINA RINGENS (*Lamarck*). A few in the sand from between Ferry House and Millbay.

MILIOLINA SEMINULUM (*Linn.*). Abundant in samples of sand and mud taken between Ferry House and Millbay, near the mouth of Salcombe Harbour. The specimens here were exceptionally large. Present, but less numerous, at the Salstone, both on the shore and in mud from the channel, and also in sand from the north-east end of Salcombe Harbour.

MILIOLINA BICORNIS (*Walker and Jacob*). A few specimens only in sand from between Ferry House and Millbay, from the north-east end of Salcombe Harbour, and from the Salstone.

MILIOLINA AGGLUTINANS (*d'Orbigny*). Occasional specimens from the Salstone, and from the mud dredged in the channel immediately to the west of it.

HAPLOPHRAGMIUM CANARIENSE (*d'Orbigny*). Occasional specimens in sand from the north-east end of Salcombe Harbour and from the channel west of the Salstone.

TEXTULARIA GRAMEN, *d'Orbigny*. A few from the sand between Ferry House and Millbay, and a few from the Salstone.

TEXTULARIA AGGLUTINANS, *d'Orbigny*. Found in all the samples examined, being most plentiful at the north-east end of Salcombe Harbour.

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* By R. H. WORTH.

TEXTULARIA SAGGITULA, *Defrance*. Occasional specimens from the north-east end of Salcombe Harbour and from the channel to the west of the Salstone.

BULIMINA PUPOIDES, *d'Orbigny*. A few specimens from all grounds.

BOLIVINA DILATATA, *Reuss*. A few specimens from the shore on the Salstone and from the channel to the west of it.

BOLIVINA PUNCTATA, *d'Orbigny*. A few from all localities except the Salstone.

LAGENA STRIATA, *Williamson*. A few from north-east end of Salcombe Harbour and from the sand between Ferry House and Millbay.

LAGENA SULCATA (*Walker and Jacob*). Common in the channel to the west of Salstone and in the sand between Ferry House and Millbay. A few from the north-east end of Salcombe Harbour, and from mud between Ferry House and Millbay.

LAGENA LÆVIS (*Montagu*). A few from the mud near the Ferry House, and a few from the channel to the west of the Salstone.

LAGENA HEXAGONA (*Williamson*). A few between Ferry House and Millbay, and a few from channel west of the Salstone.

LAGENA ORBIGNYANA (*Seguenza*). A few recorded from all samples, excepting that from the shore at the Salstone.

LAGENA LAGENOIDES (*Williamson*). A few seen in the mud from the channel west of Salstone only.

LAGENA APICULATA, *Reuss*. A few from the sand between Ferry House and Millbay only.

LAGENA SEMISTRIATA, *Williamson*. A few from the channel west of the Salstone only.

POLYMORPHINA LACTEA (*Walker and Jacob*). A few from the mud between Ferry House and Millbay only.

SPIRILLINA VIVIPARA, *Ehrenbaum*. A few from the channel west of Salstone.

GLOBIGERINA BULLOIDES, *d'Orbigny*. Small specimens were fairly common in the mud from the channel west of the Salstone.

DISCORBINA ROSACEA (*d'Orbigny*). In both sand and mud from between Ferry House and Millbay.

PLANORBULINA MEDITERRANENSIS, *d'Orbigny*. A few specimens from all samples, excepting that from Salstone.

TRUNCATULINA LOBATULA (*Walker and Jacob*). Moderately common in all samples. Most numerous (24 per cent.) in the sand from Millbay.

ROTALIA BECCARII (*Linn.*). One of the commonest foraminifera in all parts of the estuary. In the sample from the shore on the Salstone 77 per cent. of the specimens counted belonged to this species; in that from the channel west of Salstone 22 per cent.; in that from the north-east end of Salcombe Harbour 42 per cent.; in those from between Ferry House and Millbay 13 per cent. on the sand, 16·5 per cent. on the mud; and in that from Millbay sand 16 per cent.

NONIONINA DEPRESSULA (*Walker and Jacob*). The most abundant species in the samples from the Ferry House to Millbay, where it formed 26 and 29 per cent. of the specimens counted from the sand, 19 per cent. of those from the mud. It was less common in the sample from north-east end of Salcombe Harbour (4 per cent.). It was not found in the first sample from the shore at Salstone, but a few specimens were seen in a later one taken at the same place. In the sample of mud dredged from the channel to the west of the Salstone this species formed 29 per cent. of the foraminifera counted.

NONIONINA STELLIGERA, *d'Orbigny*. A few from the sample of muddy sand taken between Ferry House and Millbay.

POLYSTOMELLA CRISPA (*Linn.*). One of the foraminifera most frequently met with in the Salcombe estuary. It was present in numbers in all the samples examined, and formed a considerable percentage of the whole number of specimens in all cases in which they were counted. The figures are: Salstone, 18 per cent.; channel west of Salstone, 18 per cent.; north-east of Salcombe Harbour, 28 per cent.; sand between Ferry House and Millbay, 18 per cent.; mud near the Ferry House, 18 per cent.; sand from Millbay, 6·5 per cent.

POLYSTOMELLA STRIATO-PUNCTATA (*Fichtel and Moll.*). This was found in both the samples from between the Ferry House and Millbay, and in that from the channel west of the Salstone. The specimens from the latter sample make it very doubtful whether the specific difference between *Polystomella crispa* and *Polystomella striato-punctata* can be maintained. Every variety occurs from the typical *P. crispa*, with well developed markings, hyaline test and carinate margin, to equally typical specimens of *P. striato-punctata*, with short and almost insignificant markings, semi-porcellanous test, and margin well rounded. At least twenty intermediate forms were obtained from a small sample.

PORIFERA.

[Nomenclature: R. HANITSCH, "Revision of Generic Nomenclature and Classification in Bowerbank's British Spongiadæ," *Trans. Liverpool Biol. Soc.* vol. viii. 1894.]

SYCON COMPRESSUM, *Auctt.* On the rocks at mouth of Salcombe Harbour.

SYCON CORONATUM, *Ellis and Solander.* Dredged in Salcombe Harbour.

HALICHONDRIA PANICEA, *Pallas.* On the rocks at mouth of Salcombe Harbour.

HYMENIACIDON SANGUINEUM, *Grant*. Very abundant on the Salstone and other parts of the Kingsbridge estuary, forming large clusters on the muddy gravel of the shore.

SUBERITES DOMUNCULA, *Olivi*. On the shore at the Salstone; also common in dredgings in the channel, both in Kingsbridge estuary and in Salcombe Harbour. Inhabited by hermit-crab (*Eupagurus cuanensis*).

CLIONA CELATA, *Grant*. Boring in shells dredged in Salcombe Harbour.

HYDROZOA.

[Nomenclature: HINCKS, *British Marine Hydroids*.]

HYDRACTINIA ECHINATA (*Fleming*). On shells inhabited by *Eupagurus Bernhardus* from the Salstone, and from the channel between the Salstone and Snape's Point.

CLYTIA JOHNSTONI (*Alder*). Abundant on shells and weeds dredged in all parts of the channel from the Salstone to the mouth of Salcombe Harbour.

OBELIA GENICULATA (*Linn.*). Dredged in Salcombe Harbour: a small colony growing on *Trochus magus* shell.

HALECIUM BEANII, *Johnston*. Dredged between Salstone and Snape's Point.

SERTULARELLA GAYI, *Lamouroux*. Dredged in the "Bag" off Snape's Point, a clean shell-gravel ground.

SERTULARELLA POLYZONIAS (*Linn.*). A few small pieces only, dredged in the channel between Salstone and the mouth of Salcombe Harbour.

SERTULARIA ARGENTEA, *Ellis and Solander*. Common in dredgings from the channel west of the Salstone to the mouth of Salcombe Harbour.

SERTULARIA PUMILA, *Linn.* Growing on *Laminaria*, etc., on the rocks at the mouth of Salcombe Harbour.

ANTENNULARIA ANTENNINA (*Linn.*). Dredged in the channel between Salstone and Snape's Point.

AGLAOPHENIA TUBULIFERA, *Hincks*. Small colony dredged in the channel west of Salstone.

PLUMULARIA SETACEA (*Ellis*). Abundant, growing on *Ascidiella* from the channel west of the Salstone. Several colonies were dredged also between Salstone and Snape's Point, and one or two small ones from Salcombe Harbour.

ACTINOZOA.

[Nomenclature: GOSSE, *British Sea Anemones and Corals*.]

SAGARTIA BELLIS (*Ellis and Solander*). This anemone occurred in extraordinary profusion in certain parts of the estuary. The conditions under which it can best flourish are found where stones or gravel lie from an inch to three or four inches beneath the surface of fine mud. The anemone attaches itself to the stones or gravel, the body becomes often much elongated, and the disc is protruded and expanded above the surface of the mud. In some places the mud-banks are carpeted with these expanded discs, which may be seen before the tide has quite left the bank. When the bank is dry the discs of the anemone are contracted, and what appear to be a number of holes are seen in the mud. This condition of things is found especially in the Kingsbridge estuary—on the Salstone and on the shore between Halwell Point and Pilworthy Point large patches of ground suitable for the species exist—and is also frequent at the north-east end of Salcombe Harbour. In the parts of the harbour nearer the mouth the anemone often occurs on the banks, but is never met with in such abundance as in the upper parts of the estuary. Gosse (*British Anemones*, p. 33) describes what appears to be a similar condition of things to that found on the mud-banks at Salcombe, in the Fleet and the Backwater at Weymouth, though he says that the anemone simply rests on the mud with its broad, flat base. This is certainly not the case in the Salcombe estuary, nor is it so in the River Yealm, near Plymouth, where we also meet with the same phenomenon. Further, Gosse speaks of the Weymouth specimens as a "breed of the species" which deviates from the "normal habit." It would, we think, be more correct to say that the "normal habit" of the species is to live in the estuarine mud-flats. This is where its centre of distribution is to be found, whilst individuals of the species extend to suitable and sheltered situations in the rock-pools along the more open coast. As has already been pointed out by one of us,* it is of primary importance, when considering the adaptation of species to their environment, that the true centre of distribution of the species should be known, for it is to the conditions there prevailing that the species is best adapted, and it is there that the species is kept true.

SAGARTIA PARASITICA (*Couch*). Found in the usual position, namely, on the shell inhabited by *Eupagurus bernhardus*. On the shore at Salstone, and dredged from the channel between Salstone and Snape's Point.

ADAMSIA PALLIATA (*Bohadsch*). Dredged in the channel between Salstone and the mouth of Salcombe Harbour. Commensal with *Eupagurus Prideauxii*.

ANTHEA CEREUS, *Ellis and Solander*. Living on the rocks at the mouth of Salcombe Harbour and also in the channel of the harbour itself, where it was dredged.

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* *Journ. Mar. Biol. Assoc.* vol. v. 1899, pp. 367 and 473.

ACTINIA MESEMBRYANTHEMUM, *Ellis and Solander.* On the rocks at the mouth of the harbour. One or two attached to stones at Millbay.

TEALIA CRASSICORNIS (*Müller*). On the rocks at the mouth of the harbour.

HALCAMPA CHRYSANTHELLUM (*Peach*). One specimen of this species was found buried in the sand of the zostera bed near Millbay, on the eastern side of Salcombe Harbour.

CERIANTHUS, sp. A number of specimens were obtained in the zostera banks on the western shore near the mouth of Salcombe Harbour (under Marine Hotel). Not met with elsewhere in the estuary.

ECHINODERMA.

[Nomenclature: JEFFREY BELL, *Catalogue of the British Echinoderms in the British Museum.*]

SYNAPTA INHÆRENS (*O. F. Müller*). Not uncommon in the sand of the zostera banks near the mouth of Salcombe Harbour on both the east and west sides. The soil is a moderately clean sand with a small admixture of mud.

CUCUMARIA PENTACTES (*Montagu*). Found under a stone amongst the rocks at the mouth of Salcombe Harbour.

ASTERIAS RUBENS, *Linn.* Only one specimen of this common species was found. This was dredged in the channel west of the Salstone, in the Kingsbridge estuary.

ASTERIAS GLACIALIS, *Linn.* One very large specimen on the shore at the south end of the Salstone. This is the first record we have seen of this species being found east of Bolt Head (cf. *Journ. Mar. Biol. Assoc.* v. 1899, p. 467).

OPHIURA CILIARIS (*Linn.*). One specimen dredged on the clean shell gravel of the "Bag," at the entrance to the Kingsbridge estuary.

OPHIOCNIDA BRACHIATA (*Montagu*). This is one of the many species first described by Montagu from specimens obtained at Salcombe. (*Trans. Linn. Soc.* vii. 1804, p. 84). It was rediscovered in the same locality by Norman (*Annals and Mag. Nat. Hist.* S. VII. vol. iv. p. 289). It occurs on the eastern side of the harbour close to low-water mark at spring tides, and is most common at the edge of the zostera beds north of Millbay Sands. When placed upon sand in a vessel of sea-water these starfish burrow rapidly, sinking vertically into the sand, but generally leaving the ends of the arms above the surface.

OPHIOTHRIX FRAGILIS (*O. F. Müller*). Never met with in numbers, but occasional specimens were found on the shore, generally under stones, on the Salstone and amongst the rocks at the mouth of Salcombe Harbour. A few were also dredged in the Kingsbridge estuary.

AMPHIURA ELEGANS (*Leach*). Found in all dredgings, and also on the shore at Salstone.

ECHINUS MILIARIS, *Gmelin*. Not uncommon in dredge material obtained in the channel from the Salstone to the mouth of Salcombe Harbour. Not found on the shore.

ECHINOCARDIUM CORDATUM (*Pennant*). Very common in the clean sand between the zostera beds to the north of Millbay, on the east side of Salcombe Harbour. Specimens are seldom found actually in the zostera banks themselves. When the sand is uncovered by the tide, the presence of the *Echinocardium* is indicated by the holes in the sand through which the tube feet of the urchin are protruded. The mollusc *Montacuta ferruginosa* is often found commensal with the *Echinocardium*.

NEMERTINA.*

[Nomenclature: BÜRGER, *Nemertinen des Golfes von Nepeal*, 1895, Naples Monograph, No. 22.]

CARINELLA ANNULATA (*Montagu*). Mr. Beaumont obtained this species in the zostera banks between Ferry House and Millbay, in September, 1898.

CARINELLA SUPERBA, *Kölliker*. This species was frequently found on the shore both in the Kingsbridge estuary and in Salcombe Harbour. It occurred on both sides of the Salstone, on the shores at the north-east end of Salcombe Harbour, as well as on the banks near the mouth, immediately to the north of Millbay. A specimen was also obtained in dredge material from the channel between Salstone and Snape's Point.

CARINELLA POLYMORPHA (*Renier*) was found on the shore on the west side of the Salstone.

LINEUS LONGISSIMUS (*Gunnerus*). Several specimens were dredged in the channel between Salstone and Snape's Point.

LINEUS BILINEATUS, *McIntosh*. Obtained on the shore near the mouth of Salcombe Harbour. It was common in clean sand (with a little zostera) between the Ferry House and Millbay, on the eastern side; one was obtained on the western side under the Marine Hotel, and one in the fine mud to the north-east of the Salstone.

MICRURA FASCIOLATA, *Ehrenberg*. Several specimens were dredged in the channel in Salcombe Harbour. None were recorded from higher up the estuary.

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* The list of species in this group is probably incomplete. We are indebted to Messrs. R. C. PUNNETT and W. I. BEAUMONT for assistance in the identification of those specimens which are recorded.

TURBELLARIA.

PROSTHECERÆUS VITTATUS (*Montagu*). Another species first described by Montagu from this locality. We found several specimens on the shore at a 16-ft. tide at the Salstone. Montagu's specimens were also obtained from the shore at Salstone (*Trans. Linn. Soc.* vol. xi., 1807).

PROSTHIOSTOMUM, sp. Dredged in the channel between Salstone and Snape's Point. Agrees closely with one previously taken at Plymouth by Mr. Garstang. Both are remarkably narrow and elongated, and are referable almost certainly to *P. siphunculus*, Delle Chiaje; but further observations on the living animal are needed to remove all doubt. This is the first record of the genus in British waters. [W. G.]

GEPHYREA.*

PHASCOLOSOMA VULGARE, *Blainville.* Large specimens of this species were numerous in the Kingsbridge estuary, in the bay immediately to the north of Pilworthy Point. At the north end of this bay, 40 to 50 yards south of the first reef of rocks, a patch of ground was found, measuring about 10 yards by 3 yards, where two or three of these large specimens were found in each spadeful of the soil. The ground was composed of stiff clay-gravel, lying on hard clay which passed quickly into soft rock. The species was also abundant, but the specimens were of smaller size, on the eastern shore of Salcombe Harbour, a little to the south of Ditch End, where the ground is composed of hard muddy gravel. One specimen was obtained on the same side of the harbour near Millbay.

PHASCOLOSOMA PELLUCIDUM, *Keferstein.* This species was much more widely distributed than the preceding. It was very common in the zostera banks on the east side of Salcombe Harbour between Millbay and Ferry House, as well as on the western side under the Marine Hotel. It was also taken on the eastern shore from the Ferry House to Ditch End, but was here less common than *P. vulgare.* Single specimens were taken on the zostera banks at the north-east end of Salcombe Harbour, and it was not uncommon on both the western and south-eastern shores of the Salstone, where the ground is hard.

PHASCOLION STROMBI (*Montagu*). One specimen in a shell of *Turritella communis*, from the channel between Snape's Point and the mouth of the harbour. The specimen was identified by Mr. Todd.

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* The two species of Phascolosoma were identified by Mr. A. E. SHIPLEY.

POLYCHAETA.*

[Nomenclature: DE SAINT-JOSEPH, "Les Annélides Polychètes des Côtes de Dinard," *Ann. Sci. Nat. Zoologie*, 1887–95; "Les Annélides Polychètes des Côtes de France (Manche et Océan)," ditto, 1898.]

SYLLIS HAMATA, *Claparède*. Dredged in the channel between Salstone and Snape's Point.

Other Syllids, the species of which have not been determined, were dredged in all parts of the estuary.

AMBLYOSYLLIS (GATTIOLA) SPECTABILIS, *Johnston*, was dredged in the channel west of the Salstone.

MYRIANIDA MACULATA, *Claparède*. One specimen, with a chain of six or seven buds, found on the fine mud on the north-east side of the Salstone. A second quite young example also came from the same locality, and the species was dredged in the channel west of the Salstone. This is almost certainly the *Nereis pinnigera* of Montagu (*Trans. Linn. Soc.* ix. 1808, p. 111, Pl. VI. Fig. 3), although de Saint-Joseph (*Ann. Sci. Nat.* xx. 1895, p. 195) does not adopt Montagu's specific name, giving it only as a doubtful synonym. The Salstone, where our specimens were taken, was one of Montagu's favourite hunting grounds.

EUPHROSYNE FOLIOSA, *Aud. et Edw.* Three specimens, dredged in the channel between Salstone and Snape's Point.

APHRODITE ACULEATA, *Linn.* One small specimen only of this sand-burrowing species was obtained. It was 28 mm. long, and came from Millbay Sands.

† LEPIDONOTUS SQUAMATUS (*Linn.*). Dredged in the channel between the Salstone and Snape's Point, as well as in the channel in Salcombe Harbour. It was also obtained on the shore under the Marine Hotel.

GATTYANA CIRROSA (*Pallas*). Found on the shore living in the tubes of *Amphitrite Johnstoni* on the Salstone, south of Halwell Point and near the mouth of Salcombe Harbour (under Marine Hotel).

LAGISCA, sp. Dredged in the channel west of the Salstone.

HARMOTHOË SPINIFERA (*Ehlers*). Dredged in the channel west of the Salstone, and between the Salstone and Snape's Point.

HARMOTHOË SETOSISSIMA (*Savigny*). On the eastern shore of Salcombe Harbour.

HARMOTHOË LUNULATA (*Delle Chiaje*). On the shore of the bay north of Pilworthy Point.

EVARNE IMPAR (*Johnston*). Dredged in the channel between the Salstone and the mouth of Salcombe Harbour.

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* By E. J. ALLEN, with the exception of the *Polynoidæ*, by T. V. HODGSON.

† For the *Polynoidæ* the terminology adopted is that of McINTOSH, *Monograph of British Annelids*, part ii., Ray Society, London, 1900.

LEPIDASTHENIA ARGUS, *Hodgson.* Found in the tubes of *Amphitrite Edwardsi,* on the shore between Salcombe town and Sandhill Point (under Marine Hotel). For details of this new species see p. 250 of the present number of this Journal.

STHENELAIS BOA (*Johnston*). All the specimens had brown elytra. The species was met with on the Salstone and near the mouth of the harbour, between the Ferry House and Millbay. It was never numerous. Specimens were also dredged in the channel between the Salstone and Snape's Point.

MARPHYSA SANGUINEA (*Montagu*). A specimen was met with on the south-east shore of the Salstone; a few specimens were found at the north-east end of Salcombe Harbour, on the eastern shore, and it was also taken on the same side of the harbour between the Ferry House and Millbay.

MARPHYSA BELLII (*Aud. et Edw.*). Three specimens from the north-east side of the Salstone, one from the south-east side, and one from near the mouth of Salcombe Harbour (under Marine Hotel). The gills begin on the seventeenth segment and occur on 23 segments in the specimens from the Salstone. In the one from under the Marine Hotel they begin on the eighteenth and occur on 29 segments. The species has previously been found on the north coast of France and in the Mediterranean (Audouin et Edwards, Marenzeller, de Saint-Joseph).

ARABELLA (MACLOVIA) IRICOLOR (*Montagu*). (For the synonymy of this species see Willey, *Journ. Mar. Biol. Assoc.* vol. vi. p. 98.) Obtained by digging in the muddy gravel on the west side of the Salstone and in the sand near the mouth of the harbour. One or two specimens only were found in each locality.

LUMBRICONEREIS LATREILLI, *Aud. et Edw.* (This is the name adopted by de Saint-Joseph. It seems likely, however, that *L. fragilis* (Müll) is the same species.) A number of specimens were found on the west side of Salcombe Harbour, under the Marine Hotel. The species was also met with on the zostera banks at the north-east end of Salcombe Harbour, in the Kingsbridge estuary opposite Halwell Point, and on the west side of the Salstone.

NEREIS (PRAXITHEA) IRRORATA (*Malmgren*). (For the synonymy of this species see Saint-Joseph, *Ann. Pol. Dinard. Ann. Sci. Nat.* S. VII. v. p. 263).

At Salcombe *N. irrorata* was most plentiful in the muddy gravel on the west side of the harbour, near the mouth (under Marine Hotel), where a number of specimens were found. Two specimens were also taken on the east side of the harbour, and a single one in the Kingsbridge estuary, south of Halwell Point. In all cases but one the ground was muddy gravel. The animals were always found inhabiting a membranous tube, formed of hardened mucus, with a few particles of sand and mud attached, as described by Saint-Joseph (*Ann. Sci. Nat.* S. VII. xx. p. 216). When the worms of this species were removed from their tubes and placed upon clean sand in a vessel of sea-water, they remained on the surface of the sand for some time, moving about, but making little attempt to burrow. After several hours, however, they were found buried in the sand, inclosed in a new tube made of secreted mucus, which was doubtless produced by the numerous glands which are found on the parapodia and on the sides of the body. The great development of these glands is one of the characteristic features of the species.

NEREIS (PERINEREIS) CULTRIFERA, *Grube.* Of the five species of Nereis found on the shore in the Salcombe estuary, by far the most common is *Nereis cultrifera.* It is found practically everywhere, from Garston Point to the mouth of the harbour, excepting on the very fine mud in the upper parts of the estuary. It is most common, however, where the soil is composed of gravel mixed with more or less sand and mud. In this respect its distribution resembles that of *N. irrorata*, though on the whole it is a much more ubiquitous species than the latter. Young specimens were numerous in dredge material.

NEREIS (EUNEREIS) LONGISSIMA, *Johnston.* (See Saint-Joseph, *Ann. Sci. Nat.* S. VIII. vol. v. 1898.) This is a well-marked species with a restricted distribution, which is well shown by the localities in which it is found in the Salcombe estuary. It is most at home in fine muddy sand, the soil most suitable for it being generally found around the margins of the large banks of the finest sticky mud, which occupy considerable areas in the upper parts of the estuary. In these mud-banks themselves it does not appear to flourish. It was found most abundantly in the mud to the south of Garston Point and on the southern side of the bay immediately below Halwell Point (under the limekiln). It was not uncommon in soil of the proper kind on the Salstone. Near the mouth of Salcombe Harbour occasional specimens only were met with. *Nereis longissima* burrows very rapidly in fine sand, and I agree with Saint-Joseph in saying that it does not appear to form a tube like *N. irrorata.* When placed upon fine sand in a vessel of clean sea-water it generally commences to burrow immediately, and rapidly disappears beneath the surface of the sand. The proboscis seems to play an important part in the burrowing process, being constantly protruded and withdrawn as the head becomes buried.

It is interesting to note that *Nereis longissima* was obtained by the *Porcupine* off the west of Ireland at a depth of 1,366 fathoms, on a bottom of fine clayey mud (Ehlers, *Beiträge zur Kenntniss der Ver-*

ticalverbreitung der Borstenwürmer im Meere. Zeitschr. wiss. Zool. xxv. 1875 p. 20).

The specimens of *N. longissima* obtained at Salcombe were generally of a perfectly uniform light shade, which was nearly flesh colour. One specimen, however, from the western side of the Salstone was very brilliantly coloured. The general ground tint was a purple-grey, and this was covered in patches with a bright chrome-yellow pigment. At the anterior end of the dorsal surface the yellow patches were found covering each side of every segment, leaving a central patch of the purple-grey ground colour between. Behind the first 50 or 60 segments the yellow patches were scattered irregularly. On the ventral surface the anterior segments were almost covered with the yellow, and behind this a median line of yellow extended backwards for some distance.

NEREIS DIVERSICOLOR, *O. F. Müller*. This worm was numerous only in a small gully traversed by a stream of fresh water, which runs into Southpool Lake just below the Rectory (see Chart). Occasional specimens were found in other parts of the harbour. The distribution of this species at Plymouth shows it to be an essentially brackish-water animal, which is in agreement with what we found at Salcombe.

NEREIS FUCATA, *Savigny*. The normal habit of the worm is to live in the upper coils of a shell inhabited by a hermit-crab. We did not specially seek for it when at Salcombe, and the single specimen recorded was given me by some children who were catching hermit-crabs when we were collecting on Millbay Sands.

PHYLLODOCE. Two or three undetermined species of Phyllodoce were common in dredge material, especially in that from the Kingsbridge estuary.

EULALIA PUNCTIFERA, *Grube*, was identified from material dredged in the channel between Salstone and Snape's Point.

EULALIA VIRIDIS (*Müller*) was also found in dredge material obtained between Salstone and Snape's Point.

NEPHTHYS HOMBERGII, *Audouin et Edwards*, must be regarded as one of the commonest, if not the commonest, shore Polychaete in Salcombe estuary. It is met with on grounds of all kinds, excepting possibly the very finest mud, and seems about equally distributed from Garston Point to the mouth of the harbour. On the clean sand at Millbay numerous very small specimens were found, which in some places were almost the only living creatures in the sand.

NEPHTHYS CAECA (*Fabricius*) was found only on the banks near the mouth of the harbour, being most numerous on the eastern side. The specimens were generally of large size. The habit of the species seems to resemble that of *N. Hombergii,* although in this case the local distribution is very different. The two species (*N. caeca* and *N. Hom-*

bergii) differ in geographical distribution, *N. caeca* being an Arctic species not found in the Mediterranean, whilst *N. Hombergii* is a Mediterranean form not extending to northern seas.

GLYCERA CONVOLUTA, *Keferstein*, was nowhere abundant. None were found in the Kingsbridge estuary, the two or three specimens taken being all from the shore in Salcombe Harbour.

GLYCERA CAPITATA, *Oersted*. One small specimen was dredged between the Salstone and Snape's Point.

GONIADA MACULATA (*Oersted*). Three specimens of this species were obtained from the shore near the mouth of Salcombe Harbour on the western side, and three from the eastern side. The exact nature of the soil in which most of the specimens were obtained was unfortunately not noted at the time, but two from Millbay certainly came from fine sand. *Goniada maculata* is a northern species. It was found on muddy ground by the *Pommerania* expedition, and on ooze by the *Porcupine* in 767 and 1,215 fathoms (Ehlers *Zeitschr. wiss. zool.* XXV. 1875, p. 22).

AUDOUINIA TENTACULATA (*Montagu*). Very common all over the estuary above half-tide mark, wherever the soil contains much mud mixed either with gravel or sand.

MAGELONA PAPILLICORNIS, *F. Müller*. One specimen was found on the south-east side of the Salstone, and two on Millbay Sands near the mouth of Salcombe Harbour.

SPIO SETICORNIS, *Fabricius*. This species was obtained in abundance on the shore under the Marine Hotel, on the western side of Salcombe Harbour. It was found by Mr. Hodgson in the muddy gravel above the zostera banks. It forms long, slender tubes or galleries of mucus covered with sand grains.

NERINE CIRRATULUS (*Delle Chiaje*). (See Saint-Joseph, *Ann. Sci. Nat.* S. VIII. v. 1898, p. 349.) One specimen was obtained on the shore under the Marine Hotel, on the west side of Salcombe Harbour.

NERINE CONICOCEPHALA, *Johnston*. One specimen on the east side of Salcombe Harbour.

NERINE VULGARIS, *Johnston*. One small one dredged between the Salstone and Snape's Point.

SCOLOPLOS ARMIGER, *O. F. Müller*. A few specimens found in the zostera banks near the mouth of Salcombe Harbour, on both the east and west sides. None are recorded from higher up the estuary.

NOTOMASTUS LATERICEUS, *Sars*, is one of the commonest worms found on the shore in the Salcombe estuary. It is most abundant, and the specimens are of largest size in the fine mud in the upper parts of the estuary (Kingsbridge estuary). In the muddy parts of the shore round the Salstone it was especially abundant and large. Specimens from the latter locality were found which, when killed with spirit and extended, measured up to 14 inches (35·5 cm.). The species extended to the banks in the lower parts of Salcombe Harbour, though the specimens here were not so large as those found in the mud in the upper parts of the estuary. The worm was seldom met with in gravel unless the latter contained a large quantity of mud. It was found living in a spiral burrow in the mud or sand, which was lined by a mucous secretion from the body of the worm.

Genital pores were counted in specimens in which they were swollen and distinct, and gave the following results:—*Specimen* 1: Pores on abdominal segment 2 to segment 14. *Specimen* 2: Abdominal segments 2 to 10. *Specimen* 3: Abd. segts. 2–11. *Specimen* 4: Abd. segts. 2–14. *Specimen* 5: Abd. segts. 2–14. *Specimen* 6: Abd. segts. 2–15.

ARENICOLA MARINA, *Linn.*, was common on the shores in all parts of Salcombe Harbour proper, in sand or muddy sand. In the Kingsbridge estuary, although not uncommon, it was far less frequent. In the sandbanks near the mouth of Salcombe Harbour very large specimens were met with near low-water mark belonging to the second variety of this species described by Gamble and Ashworth (*Quart. Journ. Micr. Sci.* xli. 1898). The largest specimens were from 13 to 14 inches (33 to 35 cm.) long.

ARENICOLA GRUBII, *Claparède*. (For detailed description of this species see Gamble and Ashworth, *Quart. Journ. Micr. Sci.* xliii. 1900.) One specimen only was obtained, from the muddy gravel on the west side of the Salstone.

CLYMENIDS. Three species of *Clymene* (*Praxilla*) were obtained, which are being reserved for detailed description. One species was common on the mud in the upper parts of the Kingsbridge estuary, and extended to the sandbanks near the mouth of Salcombe Harbour. On these latter banks two other species were also found.

OWENIA FUSIFORMIS, *Delle Chiaje*. Three specimens of this species were found in the clean, fine sand at Millbay.

CHÆTOPTERUS VARIOPEDATUS (*Renier*) was found on the shore at extreme low water in two places—on the west side of the Salstone and on the zostera bank near the mouth of Salcombe Harbour on the western side. In each locality two or three specimens only were obtained.

AMPHITRITE JOHNSTONI, *Malmgren*, was very abundant on the Salstone, especially on the north-east and south-east sides. It was occasionally met with on the shore in all parts of Kingsbridge estuary and Salcombe Harbour, being abundant on the western shore near the mouth of the harbour (under Marine Hotel). In the mud of the Salstone the ends of the tubes were often covered with pieces of shell and gravel, and projected from ½ to 1 inch above the surface.

The main portion of the tube or burrow in which the worm lives is lined by a moderately hard, claylike substance of a brownish yellow colour, which seems to be formed by the action upon the mud of the mucus secreted by the animal. There is here no sign of a definitely built tube, such as that constructed, for instance, by *Lanice*, excepting at the external opening, which projected above the surface of the mud. The burrows were very frequently inhabited by the Polynoid *Gattyana cirrosa*.

AMPHITRITE EDWARDSI, *Quatrefages*, resembles *A. Johnstoni* very closely in appearance and habit, but can be readily distinguished by the fact that it possesses only 17 setigerous segments in the thorax instead of 24. In the Salcombe estuary it was found only in the zostera banks near the mouth of Salcombe Harbour, and was met with in some numbers on the western side (under Marine Hotel). On the eastern side one specimen only was taken. In the former situation (zostera bank under Marine Hotel) both *A. Johnstoni* and *A. Edwardsi* live in close proximity; but it was noted by Mr. Hodgson, who recently paid special attention, at my request, to the exact situations in which specimens of these two species could be found, that whilst *A. Johnstoni* was more common at extreme low-water mark, *A. Edwardsi* was most frequent higher up on the zostera bank. The areas of distribution of the two species overlapped to some extent, and where this occurred specimens of both might be turned up in one spadeful of muddy sand.

It has already been noted that *A. Edwardsi* was never found in the Kingsbridge estuary, in which respect its distribution again differs from that of *A. Johnstoni*, for this species was especially common on the Salstone.

The burrow of *A. Edwardsi* is very similar to that of *A. Johnstoni*. Although no projecting ends to the tubes were noted, it is quite possible that they may sometimes be made. They were by no means always found in the case of *A. Johnstoni*.

The handsome Polynoid *Lepidasthenia argus*, which is described by Mr. Hodgson for the first time in this number of the Journal (see p. 250), was found living in the burrows of *A. Edwardsi*.

LANICE CONCHILEGA (*Pallas*). Extremely abundant in patches of clean sand near the mouth of Salcombe Harbour on both sides, as well as in the sand of the bays outside the harbour, especially in the more sheltered parts of them. One or two specimens only were found at the north-eastern end of the harbour, and one or two in the Kingsbridge estuary (under limekiln). Evidently clean sand without much admixture of mud is necessary for this species to flourish.

Small specimens were obtained in dredge material from Salcombe Harbour.

THELEPUS SETOSUS (*Quatrefages*). Specimens found in dredge material obtained between the Salstone and Snape's Point, and also from Salcombe Harbour.

POLYMNIA NEBULOSA (*Montagu*) was dredged in the channel west of the Salstone.

POLYCIRRUS CALIENDRUM, *Claparède*. Obtained from dredge material between Salstone and Snape's Point.

POLYCIRRUS AURANTIACUS, *Grube*. Obtained from dredge material between Salstone and Snape's Point.

MELINNA ADRIATICA, *von Marenzeller*. (Adriat. Annel. I. *Sitzb. d. k. Akad. Wiss. zu Wien.* lxix. p. 472.) In the very finest mud, which forms large banks in the upper parts of the Salcombe estuary, a species of Melinna occurs in extraordinary abundance, the whole surface of the mud being studded with the tubes of the worm. In other parts of the estuary, even in the parts of the harbour nearest the sea, the same species is found in the mud and sand banks, though the number of specimens met with in any one spot is here not large. The centre of distribution lies undoubtedly in the mud-flats already mentioned, and the specimens found in other parts must be regarded as immigrants.

The examination of a considerable number of specimens of the species found at Salcombe leads me to conclude that it is the *Melinna adriatica* of von Marenzeller, although in some respects there are slight differences from the description given by that author. The most important of these are the number of segments in relation to the body length, and the structure of the membranous comb on the dorsal side of the fourth segment. Von Marenzeller gives the length of his specimens at 15·30 mm., and the total number of segments 78–90. The largest of the Salcombe specimens was 60 mm. long, but a portion of the tail was missing. Other Salcombe specimens gave:—Length 40 mm., segments 70; length 40 mm., segments 72; length 39 mm., segments 85; length 35 mm., segments 70; length 33 mm., segments 81; length 32 mm., segments 85; length 29 mm., segments 81; length 28 mm., segments 73. This character is clearly too variable for any weight to be attached to it.

The membranous comb of *M. adriatica* is described by von Marenzeller as having 4–8 completely rounded denticulations on its anterior border, differing in this respect from that of *M. cristata,* which Sars describes as having 12–16 very small triangular points or lobes. In the Salcombe specimens this character is subject to very considerable variations. In a few specimens there were 6–8 rounded denticulations; in one specimen I counted 8 rounded denticulations, but each of these had a very slight notch in the centre, so that it was approaching the condition of 16 denticulations. In the majority of specimens the number of denticulations is more than 12, in this respect resembling *M. cristata;* but again the amount of variation renders the character of little use as a specific distinction.

In other characters the Salcombe specimens agree with those described by von Marenzeller. The isolated dorsal hooks behind the gills as well as the ventral uncini are both well represented by von Marenzeller's figures. The uncini have generally five large teeth, one rudimentary tooth and rounded ends, with the exception of those at the end of each row, which have often four large teeth only, one rudimentary tooth and rounded ends. There is, however, a certain amount of variation in this character, as in some specimens I have found only uncini with four large teeth, like those generally found at the end of the rows; or there may be a very small and rudimentary outer tooth, representing the first of the typical five large teeth.

M. adriatica is described as having 36–47 uncini in one row. I have found in the Salcombe specimens 34, 35, 42, 43, 46; 38, 39, 42, the last three figures being obtained from different segments of the same worm.

The colour of the Salcombe specimens is not subject to much variation, and agrees with von Marenzeller's description. The red patches on the dorsal surface spoken of by the author vary in size, shape, and position, since they are due to blood showing through the skin. I need only add further that when the gills are contracted they have a distinctly greenish tinge.

It is practically certain that this species is the *Sabella curta* of Montagu (*Testacea Britannica*, p. 554; quoted in Johnston, *British Museum Catalogue*, p. 263), although some points in his description of the worm do not seem quite to agree. Montagu, however, says: "This *Sabella* is gregarious, covering the whole surface of the shore in the inlet near Kingsbridge, appearing like bits of straw covered with mud, and as close and numerous as stubble in a field," which exactly expresses what we saw in the same estuary during the present summer.

PECTINARIA BELGICA (*Pallas*). One specimen was obtained on the eastern shore at the north-east end of Salcombe Harbour, from a patch of sandy ground, and a second specimen from the north-east side of the Salstone.

SABELLA PAVONINA, *Savigny*. On the south-east shore of the Salstone this species was extremely abundant at dead low water with a 16-ft. tide, being often found in clusters of twenty or thirty together. It was also abundant on the mud on the west side of the Kingsbridge estuary, south of Garston Point. Other localities, where a few specimens were obtained, were the west side of the Salstone and the zostera banks at the north-east end of Salcombe Harbour. The species was entirely absent from the banks near the mouth of the harbour.

BRANCHIOMMA VESICULOSUM (*Montagu*) is another species which was first described from specimens obtained in this estuary. It occurs at a higher tidal level than *Sabella pavonina* and *Myxicola infundibulum*, and is most abundant where the soil is composed largely of gravel. It was never met with on clean sand or mud. It was most numerous on the gravel at the Salstone and in the upper parts of Salcombe Harbour.

MYXICOLA INFUNDIBULUM (*Renier*) is also a very common species in the estuary, and was well described by Montagu, who found it on the Salstone. It is very frequent on all parts of the Salstone, and in some places at the north-east end of Salcombe Harbour. It occurred in extraordinary numbers near low-water mark, on the zostera flat immediately to the south of Pilworthy Point. In the lower parts of Salcombe Harbour it was met with only occasionally, and must there be regarded as an immigrant from the upper parts of the estuary.

POTAMOCEROS TRIQUETER (*Linnæus*). Common in dredge material from Salcombe Harbour and the Kingsbridge estuary.

SPIRORBIS BOREALIS, *Daudin*. Common in dredge material from Salcombe Harbour and the Kingsbridge estuary.

CRUSTACEA.*

DECAPODA.

STENORHYNCHUS PHALANGIUM (*Pennant*). This species was present in most hauls of the dredge taken between the Salstone and the mouth of the harbour, excepting those taken in the "Bag."

STENORHYNCHUS TENUIROSTRIS (*Leach*). A few were dredged between Snape's Point and the mouth of the harbour.

INACHUS DORSETTENSIS (*Penn.*). Taken in all hauls of the dredge, excepting those in the "Bag."

INACHUS DORYNCHUS, *Leach*. Was only found on the west and south-east shores of the Salstone, between tidemarks.

MAIA SQUINADO (*Herbst*). One only was taken in the dredge between Snape's Point and the mouth of the harbour. It is, however, very commonly taken when working the tuck-net on the zostera banks and mud-flats.

EURYNOME ASPERA, *Leach*. This crab was common in dredgings taken between Snape's Point and the Salstone.

PILUMNUS HIRTELLUS (*Linn.*). One only was taken in dredging from between Snape's Point and the Salstone.

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* By R. A. TODD.

CARCINUS MÆNAS (*Penn.*). This species is moderately common on all the sand, mud, and zostera banks in Salcombe Harbour. In some localities, notably the zostera bank off Ditch End, it is abundant, although usually of a small size. In the latter place it makes burrows in the patches of mud free from zostera, each burrow being one to two feet long, and of a diameter corresponding to the size of the crab inhabiting it. The burrow starts as a more or less vertical hole three or four inches in length, runs horizontally for a foot or so and then upwards, opening on the surface. The crabs also make holes in the edges of the zostera banks, which are generally some inches above the surface of the surrounding mud, and as these holes are fairly numerous the zostera bed gradually becomes undermined at its edges, the overhanging portion ultimately breaking away.

PORTUNUS CORRUGATUS (*Penn.*). Was only taken once, in the dredge between Snape's Point and the Salstone. In the Plymouth district it is taken chiefly on the New Grounds, between the Breakwater light and Drake's Island.

PORTUNUS PUSILLUS (*Leach*). This species was commonest in dredge material from between Snape's Point and the Salstone, a few only being taken between Snape's Point and the mouth of the harbour.

PORTUNUS DEPURATOR (*Leach*). One only recorded, from dredgings between Snape's Point and the mouth of the harbour.

EBALIA TUBEROSA (*Penn.*). Present in all hauls of the dredge taken between Snape's Point and the Salstone. A few only were taken between Snape's Point and the mouth of the harbour.

EUPAGURUS BERNHARDUS (*Linn.*). Young specimens of this species were very common on the Salstone and opposite the Marine Hotel, running about between tidemarks. It was present in all the dredgings (excepting in the "Bag") in varying numbers. A few large ones were taken inhabiting *Buccinum* shells to which were attached the anemone *Sagartia parasitica.*

EUPAGURUS PRIDEAUXII (*Leach*). Several specimens of this hermit-crab were present in dredgings taken between Salstone and the mouth of the harbour, sometimes with *Adamsia palliata.*

EUPAGURUS CUANENSIS (*Thompson*). This species was taken most commonly between Snape's Point and the Salstone, a few being taken west of the Salstone and between Snape's Point and the mouth, all in the dredge. It generally inhabited a shell which was covered with the sponge *Suberites domuncula*, the shell in many cases, however, having been almost completely eaten away by the sponge.

ANAPAGURUS LÆVIS (*Thompson*). Was taken frequently in the dredge, in all parts of the channel between the mouth of the harbour and the Salstone, generally inhabiting *Turritella* shells.

DIOGENES VARIANS (*Costa*). One specimen only of this hermit-crab was taken, in the cheese-cloth trawl, on the bar, outside Salcombe Harbour.

PORCELLANA LONGICORNIS (*Penn.*). Recorded only from dredgings taken between Snape's Point and the Salstone. It was most probably, however, taken elsewhere.

PORCELLANA PLATYCHELES (*Penn.*). Recorded only from under rocks, etc., between Sandhill Point and South Sands Bay.

GALATHEA SQUAMIFERA, *Leach*. A few were taken in the dredge, between Salstone and Snape's Point, and one in a prawn-pot in 4 to 5 fathoms off Ditch End.

GALATHEA INTERMEDIA, *Lilljeborg*. This Galathea was taken very commonly in the dredge between Salstone and Snape's Point, and also, but not so commonly, between Snape's Point and the mouth of the harbour.

PALINURUS VULGARIS (*Latr.*). The "crayfish," according to the Salcombe fishermen, was sometimes taken when tuck-netting, and was occasionally found in holes at the edge of the zostera banks.

GEBIA STELLATA (*Montagu*). This interesting crustacean, first described by Montagu from specimens obtained at Salcombe, was found most commonly on the zostera bank opposite the Marine Hotel, and in the muddy sand below the Ferry House, a few being taken in other localities, *i.e.* one on the west shore of the Salstone, two in the zostera between Snape's Point and Salcombe town, and two under the Marine Hotel. The burrows do not appear to be of very great length; they are nearly always branched, some of the branches being vertical, at their ends at least. Two or more of these branches open at the surface, whilst others are blind. Leach records burrows of a hundred feet or more in length on the shores of Plymouth Sound, but none of those we followed were more than two or three feet long.

Norman found *Gebia* at Salcombe in the locality where we have now found it to be abundant (eastern side of harbour). [*Ann. Mag. Nat. Hist.* 1899, p. 289.]

HOMARUS VULGARIS (*Milne-Edwards*). Occasionally taken in shove-nets, and also when tuck-netting.

CRANGON VULGARIS, *Fabricius*. On all the mud-flats in the Kingsbridge estuary, and in the upper parts of Salcombe Harbour, during the time we were at Salcombe (June to September), large numbers of young of the common shrimp (*Crangon vulgaris*) were found, wherever pools of water were left on the surface of the mud. Full-grown specimens, or specimens of a marketable size, on the other hand, we only took on the bar outside the harbour, never in the estuary itself, and from information we received from local fishermen it appears that there is no fishery for them, although small shrimp-trawls and shove-nets are often worked for the capture of prawns (*Palæmon serratus*).

CRANGON TRISPINOSUS (*Hailstone*). Eight specimens were taken on the clean sand of the bar, with the cheese-cloth trawl.

ATHANAS NITESCENS (*Mont. MSS.*). One specimen only was taken in the dredge between the Salstone and Snape's Point.

HIPPOLYTE (VIRBIUS) VARIANS (*Leach*). This species was generally taken when using the cheese-cloth trawl on the zostera banks, especially opposite the Marine Hotel, being often of a bright green colour. It was also found in rock pools between Sandhill Point and South Sands Bay.

HIPPOLYTE CRANCHII, *Leach*. One only was taken in the dredge between Snape's Point and the mouth of the harbour.

PALÆMON SERRATUS (*Penn.*). The common prawn was present on all the zostera, mud, and sand banks when they were covered with water, but was not often left on them when uncovered, as it always retires to deeper water when the tide starts to ebb.

*MACROMYSIS FLEXUOSA (*Müller*). Very common on the zostera bank south of Pilworthy Point, common on the zostera off Ditch End, a few only from zostera bank between Snape's Point and Salcombe, and two from the zostera on the eastern side of Salcombe Harbour between Ferry House and Millbay.

MACROMYSIS INERMIS (*Rathke*). A few were taken in the cheese-cloth trawl on the zostera bank off Ditch End, and three on the zostera under the Marine Hotel.

MACROMYSIS NEGLECTA (*G. O. Sars*) (?). In cheese-cloth trawl south of Pilworthy Point, on zostera off Ditch End, and under the Marine Hotel (west side of Salcombe Harbour).

SCHISTOMYSIS ARENOSA (*G. O. Sars*). One only was taken, in the cheese-cloth trawl on the bar outside Salcombe Harbour.

SCHISTOMYSIS HELLERI (*G. O. Sars*). Not uncommon in pools on mud-flat north of the Rectory, on east side of Southpool Lake. I am indebted to Mr. Beaumont for the following note: "Not quite typical; more slender, telson narrower and less curved in outline, and with fewer spines (14–16), inner uropod with 12–13 spines, outer uropod hardly ⅓ longer than the inner."

AMPHIPODA.

[Nomenclature in general that of G. O. SARS, *Crustacea of Norway*, vol. i.]

BATHYPOREIA PELAGICA, *Spence Bate*. One specimen only was taken, in the cheese-cloth trawl on the bar.

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* The Mysidæ were identified by Mr. W. I. BEAUMONT. The nomenclature is that of SARS, *Middlehavets Mysider*.

UROTHOE, sp. Several specimens were taken in the cheese-cloth trawl on the bar.

LEUCOTHOE SPINICARPA (*Abild*). One was taken in the dredge, west of Salstone.

PONTOCRATES ALTAMARINUS (*Spence Bate*). Two specimens were taken on the bar.

PARATYLUS FALCATUS (*Metzger*). One specimen was taken on the bar, in the cheese-cloth trawl. It is, I believe, new to Britain. Sars (*Crust. of Norway*, vol. i. p. 466) records it from the south-east coast of Norway, Karmo, and the west coast of Finmark. Other records are: East Frisian coast (Metzger), French coast (Chevreux), Dutch coast (Hoek).

DEXAMINE SPINOSA (*Montagu*). A few were taken in the cheese-cloth trawl on the zostera off Ditch End, three on the zostera under the Marine Hotel, and three in the dredge, between the Salstone and the mouth of the harbour.

GAMMARUS LOCUSTA (*Linn*). Taken in nearly all hauls of the dredge and cheese-cloth trawl; commonest on the zostera south of Pilworthy Point.

GAMMARUS CAMPYLOPS, *Leach*. Taken commonly in the cheese-cloth trawl on the zostera banks on the east side of Salcombe Harbour, between Ferry House and Millbay Sands.

MELITA GLADIOSA, *Spence Bate*. One or two specimens were dredged in the channel in Salcombe Harbour.

AMPHITHOE RUBRICATA (*Montagu*). Present in most hauls of the dredge, excepting those taken in the "Bag."

COROPHIUM GROSSIPES (*Linn*). Found very commonly in the mud-flat off Ditch End, living in vertical burrows 4 to 5 inches long. A few were also taken in the cheese-cloth trawl on the zostera bank between Snape's Point and Salcombe town.

PHTHISICA MARINA, *Slabber*. A few were taken on the zostera bank off Ditch End, and two on the zostera bank on the east side of Salcombe Harbour, between Ferry House and Millbay Sands.

PROTELLA PHASMA (*Montagu*). Common in dredge material.

ISOPODA.

[Nomenclature that of G. O. SARS, *Crustacea of Norway*, vol. ii.]

APSEUDES TALPA (*Montagu*). Not uncommon in dredgings taken between the Salstone and Snape's Point.

ANTHURA GRACILIS (*Montagu*). One specimen only was taken when dredging in the "Bag."

GNATHIA MAXILLARIS (*Montagu*). Very common in dredgings from the harbour, and two from the "Bag."

SPHAEROMA CURTUM, *Leach.* One dredged in the channel between Snape's Point and the mouth of Salcombe Harbour.

IDOTHEA BALTHICA, *Pallas.* Present in most hauls of the cheese-cloth trawl.

ARCTURUS GRACILIS (*Goodsir*). Taken on the zostera off Ditch End, and also in dredgings from the channel in Salcombe Harbour.

ARCTURUS INTERMEDIUS (*Goodsir*). Two were taken in the dredge between Snape's Point and the Salstone.

ARCTURUS DAMNONIENSIS, *Stebbing.* Not uncommon in dredge material.

JANIRA MACULOSA, *Leach.* A few were taken with the dredge in the channel of Salcombe Harbour.

JÆRA MARINA (*Fabr.*). Two were taken with the cheese-cloth trawl on the zostera bank off Ditch End.

MUNNA KRÖYERI, *Goodsir.* Not uncommon in the dredge material taken between the Salstone and Snape's Point.

PYCNOGONIDA.*

[Nomenclature: P. P. C. HOEK, *Études sur les Pycnogonides* (Arch. Zoo. Exp. et Gen. ix. 1881).]

NYMPHON GRACILIS, *Leach.* Two dredged in Salcombe Harbour.

AMMOTHEA ECHINATA (*Hodge*). Not uncommon in dredgings from the harbour.

PHOXICHILUS SPINOSUS (*Montagu*). One taken in the cheese-cloth trawl on the zostera under the Marine Hotel, and two between Ferry House and Millbay.

POLYZOA.

[Nomenclature: HINCKS, *British Marine Polyzoa.*]

AETEA TRUNCATA, *Landsborough.* Dredged in the channel between Salstone and Snape's Point.

EUCRATEA CHELATA (*Linn.*). Dredged in the channel from the Salstone to the mouth of Salcombe Harbour.

SCRUPOCELLARIA SCRUPOSA (*Linn.*). Small pieces dredged in Salcombe Harbour, attached to *Trochus magus.*

BUGULA TURBINATA, *Alder.* Dredged in quantity in the channel from the Salstone to the mouth of Salcombe Harbour.

BUGULA FLABELLATA, *Thompson.* Dredged in the "Bag," at the mouth of Kingsbridge estuary, and in the channel in Salcombe Harbour.

UMBONULA VERRUCOSA (*Esper*). Common on the rocks at the mouth of Salcombe Harbour.

CRISIA RAMOSA, *Harmer.* Dredged in all parts of the channel from Salstone to mouth of Salcombe Harbour.

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* By R. A. TODD.

LICHENOPORA HISPIDA (*Fleming*). On shells dredged in Salcombe Harbour.

AMATHIA LENDIGERA (*Linn.*). On dredge material from channel west of Salstone.

BOWERBANKIA PUSTULOSA (*Ellis and Solander*) (?). A species of Bowerbankia was common on dredge material from all parts of the channel, from the Salstone to the mouth of Salcombe Harbour. It is probably *B. pustulosa,* although the contracted zoœcia show forms similar to those figured by Hincks for *B. imbricata,* as well as those figured for *B. pustulosa,* and many intermediate stages. Hincks records *B. pustulosa* as plentiful in Salcombe Bay.

MIMOSELLA GRACILIS, *Hincks.* One piece dredged in channel west of the Salstone.

PEDICELLINA CERNUA (*Pallas*). On *Turritella* shell from the channel between Salstone and Snape's Point; on *Sertularella* from channel in Salcombe Harbour.

LOXOSOMA PHASCOLOSOMATUM, *Vogt.* On the posterior end of *Phascolosoma vulgare* from the shore north of Pilworthy Point.

[NOTE.—The incrusting Polyzoa, attached to shells, were not identified.]

MOLLUSCA.*

[Nomenclature: FORBES AND HANLEY, *British Mollusca,* 1853.]

PHOLAS DACTYLUS, *Linn.* Recent shells of this species, some of which were over five inches in length, were found in mud between Garston Point and the Salstone, accompanied by lumps of bored chalk, which were probably the remains of some cargo. One of the borings showed very distinctly that the action of the spines of the shell had played an important part in producing it. The sides of the hole were marked with a number of transverse furrows of varying length and depth, which were, as a rule, deep (perhaps $\frac{1}{100}$ inch) at one end and shelved off to nothing at the other. The furrows were only visible in the newer part of the boring, the old part being quite smooth. The shells themselves were in very good condition, the spines being prominent and sharp. This was probably due to the fact that they were boring in soft chalk, as those we get at Plymouth in the shale of Rum Bay are always much smaller (three inches long), the spines having been worn short and stumpy. It was found that only very slight pressure was necessary to make furrows in the chalk with the Pholas shells, similar to those seen in the borings themselves.

SAXICAVA RUGOSA (*Linn.*). Two specimens, attached to stones, etc., were taken in the dredge between the Salstone and the mouth of the harbour.

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* By R. A. TODD.

THRACIA PHASEOLINA, *Lamarck*. One living specimen was found lying on the sand at Millbay.

SOLEN MARGINATUS, *Pulteney*. This species is characteristic of the sand and zostera banks between Millbay and the Ferry House, being most abundant at the Millbay end in the sand. It burrows to a depth of eighteen inches or so, the hole being easily recognised by the shape of its aperture, which is oblong with a slight constriction in the middle. The animal is able to disappear down its hole much more quickly than *S. ensis*, owing probably to its shell being straight and not curved. When annoyed it frequently throws off its siphon in rings, the siphon splitting along the dark transverse bands which mark its surface.

SOLEN SILIQUA, *Linnæus*. A few specimens only of this species were found in the sand at Millbay. The aperture of the hole is oval in shape.

SOLEN ENSIS, *Linnæus*. A few shells only of this species were found. It seems to prefer a much coarser sand than *S. marginatus*, as the only place near Plymouth in which it occurs in abundance is a bank in the River Yealm, which consists of much coarser sand than that at Millbay, Salcombe. Although we have collected in the Yealm many times, so far we have only found one *S. marginatus*.

SOLEN PELLUCIDUS, *Pennant*. Several specimens of this small *Solen* were found lying on the surface of the sand at Millbay just after the tide had turned, having come out of their holes. One large one was obtained from the mud on the north-east of the Salstone. When placed in a dish of sea-water the small specimens became active at times, swimming or shooting about in search of a suitable place in which to burrow. The swimming was effected by means of the foot, which was protruded at the end of the shell, bent back over one of the valves to its fullest extent, and then suddenly straightened. The impetus received from the action was frequently sufficient to propel the *Solen* two or three inches. This movement was often repeated several times, after which the animal would attempt to burrow, again making use of its foot, which it straightened out, keeping it at the same time as thin as possible and forcing it into the sand. After entering the sand the end of the foot was first of all expanded, and then the whole foot contracted, the shell being thus drawn a little way beneath the surface. This action was repeated until the *Solen* had buried itself. When lying in sea-water on the bare glass it still tried to burrow in the same way, often making several attempts at one spot.

TELLINA INCARNATA, *Linnæus*. Shells only were found.

TELLINA FABULA, *Gronovius*. A living specimen was found in the zostera bank under the Marine Hotel, buried six or eight inches below the surface.

TELLINA SOLIDULA, *Pulteney*. Shells of this species were common on the mud near Kingsbridge. One or two living ones were found in the muddy gravel between the zostera and shore, near Ditch End, buried three or four inches below the surface.

SYNDOSMYA ALBA (*Wood*). Several living specimens were dredged in the channel off Tosnos Point.

SCROBICULARIA PIPERATA (*Gmelin*). This species was not uncommon in the mud just to the south of Snape's Point, and also in the gravel to the north of Pilworthy Point. They appear to be gregarious in habit, four or five occurring together in a small patch of suitable gravel or mud. Single ones were found in the creek below the Rectory (Southpool Lake) in gravel, south-east of Pilworthy Point, and in the gravel under the Marine Hotel. At Plymouth I have found them only in the fine mud in St. John's Lake, a branch of the Hamoaze, where they are common, occurring a dozen or so in a patch of ground a yard square.

MACTRA SOLIDA, *Linnæus*. Fairly common in the clean shell-gravel in the "Bag" off Snape's Point. Shells were very common in North and South Sand Bays. One or two specimens were obtained on the Bar. When dredging in the latter locality on October 2nd, 1896, large numbers of this species were obtained. [E. J. A.]

LUTRARIA ELLIPTICA, *Lamarck*. This bivalve was found most commonly on a sand and zostera bank off Millbay, which was only uncovered at low water. It was also not uncommon on the sand and zostera banks between Millbay and the Ferry House. Single specimens were found in the sand below Gazebo, in gravel on the south-east and in mud on the north-east shore of the Salstone. They were generally found buried a foot or more below the surface, their siphons being visible before the tide left them. When first uncovered by the tide the siphons were contracted, and the holes left by them generally filled up with sand, and it was not till nearly low-water that they were again extended to the surface. After making the aperture afresh the siphons were withdrawn two or three inches. The hole at the surface is usually oval in shape, although one was found almost exactly like that of *Solen marginatus* (see above).

One *Lutraria*, which we dredged in the channel of Salcombe Harbour, was being eaten by an *Octopus*, one valve of the shell being broken (? by the dredge). A *Lutraria* and an *Octopus* were trawled under similar circumstances in Cawsand Bay, Plymouth, on October 1st, 1900, but in this case both valves of the *Lutraria* were intact.

TAPES DECUSSATA (*Linnæus*). Several living specimens were found in muddy gravel to the north of Pilworthy Point, and also in the bight below the Rectory (Southpool Lake). They were generally buried a few inches deep in the gravel.

TAPES PULLASTRA, *Wood.* This was by far the commonest bivalve on the Salstone, especially on the western shore. It was found lying on the surface of the muddy gravel, or buried to a depth of three or four inches. A few were found on the other grounds, but it was nowhere so common as on the Salstone.

VENUS STRIATULA, *Donovan.* Living specimens of this mollusc were found lying on the surface of the clean sand at Gazebo and Millbay.

VENUS FASCIATA, *Donovan.* One or two were found lying on the clean sand in Millbay. It is most commonly found on gravelly ground, such as one finds near Plymouth, one mile west of Stoke Point.

VENUS OVATA, *Pennant.* Only two specimens were taken—one with the cheese-cloth trawl on the zostera of Salcombe estuary, and the other with the dredge between Snape's Point and the mouth of the harbour.

CARDIUM EDULE, *Linnæus.* Was commonest on the Salstone, lying on or near the surface of the muddy gravel on the west and south-east shores, and of the fine mud on the north-east. It also occurred on several other grounds, especially in the Kingsbridge estuary.

CARDIUM NORVEGICUM, *Spengler.* Shell dredged in Salcombe Harbour.

LUCINA BOREALIS (*Linnæus*). This species was found chiefly in the zostera banks on the east side of the harbour between Millbay and the Ferry House, one or two only being found in the zostera bank under the Marine Hotel. It was always buried six or eight inches deep.

LUCINA FLEXUOSA (*Montagu*). Not uncommon in the sand and zostera banks between Millbay and Ferry House, buried several inches below the surface.

MONTACUTA FERRUGINOSA (*Montagu*). This species was always found commensal with *Echinocardium cordatum* in the clean sand at Millbay, and always in the same position, *i.e.* in a burrow opposite the post-anal impression of the *Echinocardium*. Each burrow contained from one to six *Montacuta* of all sizes, generally the latter number or thereabouts. The shells, especially near the umbonal regions, were coloured red by an incrusting reddish deposit, consisting of organic débris, which Gwyn Jeffreys thinks may be due to the fæces of the animal itself. It might also be due to the fæces of the *Echinocardium*. In the case of some specimens of *Echinocardium* which were obtained from the Yealm, one *Montacuta* was found adhering to one of the post-anal spines, in the same way as *M. substriata* attaches itself to the spines of *Spatangus purpureus*.

DIPLODONTA ROTUNDATA (*Montagu*). Shell dredged in Salcombe Harbour.

KELLIA SUBORBICULARIS (*Montagu*). Was often present in dredge material, generally in dead bivalve shells in which there was a deposit of mud.

Lepton squamosum (*Montagu*). Only shells of this species were found. Canon Norman records it from Salcombe as a commensal with *Gebia stellata* (*Ann. and Mag. Nat. Hist.*, March, 1891).

Modiola modiolus (*Linnæus*). One living specimen was found on the western shore of the Salstone, half buried in the muddy gravel and attached to a stone by its byssus. Small *Modiolæ*, probably the young of this species, were not uncommon in dredge material, generally attached to stones and shells.

Crenella marmorata (*Forbes*). This species was common in dredge material, attached to or boring in the tests of Ascidians (*Ascidiella*).

Nucula nucleus (*Linnæus*). Not uncommon in dredge material from the channel off Tosnos Point.

Pinna pectinata, *Linnæus*. One or two valves of this fine mollusc were found on the west shore of Salstone.

Montagu (*Testacea Britannica*, part. i. p. 181) speaks of the occurrence of this species at Salcombe as follows :—

"They lie on a gravelly bottom covered with mud and long seaweeds, and are only to be got at particular times when the sea recedes farther than usual.

"They stand upright, with the large end about an inch above the surface; the lower end fixed by a very large, strong byssus, so firmly attached to the gravel that much force is required to draw them up; and most commonly the byssus is left behind. This beard is composed of numerous, fine, silk-like fibres of a dark purplish brown, two or three inches in length. The larger end of the shell is naturally a little open, and cannot be closed by art, but the animal is capable of effecting it. The beaks of the valves rarely cover each other exactly.

"Some of these shells have been taken annually for many years, the animal having been accounted very good food, but they require at least five or six hours' stewing to render them eatable. If this is properly attended to they are nearly as good as *Scallops*, but never so tender.

"The bank on which these shells are found probably increases, so that the water leaves a greater part bare, at every spring tide, than formerly; and in consequence they become an easy prey to crows and gulls. Few are now to be obtained but at some unusual low tide.

"We have taken them of all sizes, from one inch to one foot in length, and from their general habits cannot liken them to any of the Linnæan species. One of the largest, after the animal was taken out, weighed seventeen ounces. The animal is very disproportionate to the shell, not occupying one-half of it."

Pecten opercularis (*Linnæus*). A few living specimens were found on the Salstone. Common in dredge material.

PECTEN MAXIMUS (*Linnæus*). A few were taken in the dredge, but only half-grown. It was found not uncommonly at low tide on the zostera bank under the Marine Hotel, lying on the surface, and covered by the zostera. Scallop dredging is practised to a considerable extent in Salcombe Harbour during the winter months.

PECTEN VARIUS (*Linnæus*). Two dredged in the channel between Salstone and Snape's Point.

ANOMIA EPHIPPIUM, *Linnæus*. Was found everywhere, especially in dredge material.

CHITON FASCICULARIS, *Linnæus*. Taken in the dredge between Salstone and Snape's Point.

CHITON ASELLUS, *Chemn.* Common in dredge material.

ACMÆA VIRGINEA (*Müll.*). Not uncommon in dredge material.

CALYPTRÆA SINENSIS (*Linn.*). This species was very common in dredge material, especially that from between Snape's Point and the Salstone, attached to stones, shells, etc.

FISSURELLA RETICULATA (*Donovan*). Fairly common in dredge stuff, especially off Tosnos Point, feeding on Ascidians, sponges, etc. One was taken on the Salstone feeding on an Ascidian.

EMARGINULA RETICULATA, *Sowerby*. One only was taken attached to a shell from the "Bag."

TROCHUS ZIZYPHINUS, *Linn.* Occasional specimens were met with everywhere. The shore records of this species, and also of *T. cinerarius* and *T. umbilicatus*, are rather incomplete.

TROCHUS MAGUS, *Linn.* Common in dredgings from between Salstone and the mouth of the harbour, excepting the shell-gravel in the "Bag." A few were found on the sand at Millbay. All the shells, excepting the young ones, were covered with Polyzoa, nullipore and algæ.

TROCHUS UMBILICATUS, *Montagu.* Not recorded from dredgings; probably ubiquitous at higher tidal levels as far as the shore was concerned, excepting on the fine mud, although not recorded.

TROCHUS CINERARIUS, *Linn.* Common in dredge material, and most probably at higher tidal levels everywhere on the shore, although only recorded from west shore of Salstone.

TROCHUS STRIATUS, *Linn.* Not uncommon in dredging from between Snape's Point and mouth of harbour, very common on the zostera under Marine Hotel.

LITTORINA LITTORALIS (*Linn.*) and L. LITTOREA (*Linn.*). The records of these two species are very incomplete. They are probably common everywhere on the shore, at higher tidal levels where there is any weed or stones.

RISSOA LABIOSA (*Montagu*). Was generally taken when working the cheese-cloth trawl on the zostera banks.

RISSOA ULVÆ (*Penn.*). This species was generally found in dredgings from the channel, and when working the cheese-cloth trawl on the zostera banks.

RISSOA PARVA (*Da Costa*). One specimen only was taken in the dredge, between Snape's Point and the mouth of the harbour.

PHASIANELLA PULLUS (*Linnæus*). One dredged in channel between Snape's Point and Salstone.

TURRITELLA COMMUNIS, *Risso.* Shells of this species were common, especially in dredge material. The shells were almost always occupied by a Pagurid, and covered with sponges.

CERITHIUM RETICULATUM (*Da Costa*). One or two generally taken in the cheese-cloth trawl on the zostera banks.

SCALARIA COMMUNIS, *Lamarck.* Five specimens of this mollusc were taken on the Salstone, four from the south-east shore, and the other from the south-west.

CHEMNITZIA ELEGANTISSIMA (*Montagu*). This species was very common on the zostera south of Pilworthy Point.

ODOSTOMIA EULIMOIDES, *Hanley.* One taken in the dredge west of the Salstone.

LAMELLARIA PERSPICUA (*Linnæus*). A few specimens were dredged between the Salstone and Snape's Point.

CERITHIOPSIS TUBERCULARE (*Montagu*). One in the dredgings from west of Salstone, and several from between Salstone and Snape's Point.

MUREX ERINACEUS, *Linn.* Several large specimens were dredged between Snape's Point and the mouth of the harbour, and one above Snape's Point.

PURPURA LAPILLUS (*Linn.*). The records of this species are very incomplete.

NASSA INCRASSATA (*Müll.*). Several specimens were taken by the dredge between the Salstone and Snape's Point, and a few between Snape's Point and the mouth.

NASSA RETICULATA (*Linn.*). This gasteropod was very commonly taken in a prawn-pot baited with fish, crab, octopus, etc., in four to five fathoms of water off Ditch End. It was also fairly common on the various shores, especially Salstone, although not recorded in the lists. A few were taken in the dredge.

BUCCINUM UNDATUM, *Linn.* One large whelk was found on the west shore of the Salstone. Young specimens were not uncommon in dredgings.

MANGELIA PURPUREA (*Montagu*). Shell only, taken between Snape's Point and the mouth of the harbour.

MANGELIA COSTATA (*Penn.*). A living specimen was dredged between Salstone and Snape's Point.

MANGELIA SEPTANGULARIS (*Montagu*). Shell only taken.

CYPRÆA EUROPÆA (*Montagu*). Fairly common in dredge material and on rough ground between tidemarks, *e.g.* Salstone, under the limekiln, etc.

BULLA HYDATIS, *Linn.* Fifteen living specimens of this mollusc were found on the muddy gravel on the western shore and on the clean gravel on the southern shore of the Salstone.

PHILINE APERTA (*Linn.*). Several specimens occurred in the dredgings between the Salstone and the mouth of the harbour, and some in dredging from the "Bag" off Snape's Point. On the shore it was taken with spawn on the zostera bank between Millbay and the Ferry House.

APLYSIA PUNCTATA, *Cuvier.* This species, together with quantities of spawn, was found in great abundance on the zostera banks between the Marine Hotel and Gazebo on our first visit to that locality (June 15th, 1900). On our subsequent visits, however, there were very few to be seen. A few were also found on other grounds, *i.e.* one on north-east mud, Salstone, and a few on the zostera between Millbay and the Ferry House, and one on the rocks between Sandhill Point and South Sands Bay. It occurred fairly frequently in dredge material.

PLEUROBRANCHUS PLUMULA (*Montagu*). One specimen from the rocks between Gazebo and North Sands Bay.

ARCHIDORIS TUBERCULATA (*Cuvier*). Two specimens only were found on the south-east shore of Salstone.

LAMELLIDORIS BILAMELLATA (*Linn.*). One only was taken, in the dredge between Snape's Point and the mouth of the harbour.

GONIODORIS NODOSA (*Montagu*). A few only were taken, in the dredge between Salstone and the mouth of the harbour, excepting on the shell-gravel in the "Bag."

LOMANOTUS, sp. Three specimens were dredged between the Salstone and Snape's Point.

ÆOLIS PAPILLOSA (*Linn.*). One was dredged between Snape's Point and the mouth of the harbour, and spawn found on the zostera between Millbay and the Ferry House.

CRATENA AMÆNA (*A. and H.*) One dredged between Snape's Point and the mouth of the harbour.

ELYSIA VIRIDIS (*Montagu*). A few were dredged between Salstone and the mouth of the harbour, and one was taken with the cheese-cloth trawl on the zostera between the Rectory and Ditch End.

OCTOPUS VULGARIS, *Lamarck.* Three specimens were found nested on the southern end of the Salstone (August 12th). They were also taken in the dredge, and with seine nets (tuck net) in Salcombe Harbour. For details as to the special abundance of octopus in the English Channel during the present summer, see Mr. Garstang's article on the subject in this number of the Journal, p. 260.

TUNICATA.

[Nomenclature: HERDMAN, *A Revised Classification of the Tunicata*, Journ. Linnean Soc. Zoology, xxiii.]

MOLGULA, sp. A few specimens were dredged between the Salstone and Snape's Point, and also on the shell-gravel of the "Bag" at the mouth of the Kingsbridge estuary.

STYELOPSIS GROSSULARIA (*van Beneden*). A few small specimens attached to shells, etc., were dredged in the channel west of the Salstone.

PHALLUSIA MAMMILLATA (*Cuvier*). A few specimens were found on the shore on both sides of the Salstone.

ASCIDIELLA ASPERSA (*O. F. Müller*). One of the commonest ascidians in the Salcombe estuary. It was found on the shore on the Salstone and on the zostera banks at the north-east end of Salcombe Harbour. At the end of September, 1898, *A. aspersa* were extremely abundant on these banks, whereas during the present summer (1900) they were found only occasionally. On the zostera banks the specimens were met with in clusters of two or three together lying on the surface of the bank, but not attached to it in any way. Many specimens were obtained by dredging in the Kingsbridge estuary, and it was also dredged, though in less abundance, in Salcombe Harbour.

ASCIDIELLA SCABRA (*O. F. Müller*). Common in dredge material from the Kingsbridge estuary, especially in the channel between Salstone and Snape's Point. Dredged also in Salcombe Harbour.

PEROPHORA LISTERI, *Wiegm.* Growing on shells dredged from the channel west of the Salstone.

CLAVELINA LEPADIFORMIS, *O. F. Müller.* Very common on the shore on the west side of the Salstone, attached to stones, less common on the south-east side. It was also found on the rocks at the mouth of Salcombe Harbour.

BOTRYLLUS VIOLACEUS, *H. M.-Edw.* On stones and rocks at the mouth of Salcombe Harbour. It was scarce on the shore at Salstone, and was not found elsewhere in the estuary.

AMAROUCIUM NORDMANNI, *M.-Edw.* On the shore at the Salstone in company with *Morchellium argus*, but not plentiful. The specimens were recognised and identified by Mr. Garstang.

MORCHELLIUM ARGUS, *M.-Edw.* Very abundant on the harder parts of the shore in the Kingsbridge estuary, attached to stones and gravel. It was a striking feature of the fauna on the muddy gravel forming the south-east shore of the Salstone, and was plentiful on the western side also. In Salcombe Harbour it was occasionally met with on the zostera banks, but became less frequent as the mouth of the harbour was approached. It was abundant in dredgings from the channel in the Kingsbridge estuary, especially immediately west of the Salstone.

DIDEMNIDS. Specimens were dredged in the channel west of the Salstone, and also obtained on the western shore of the same island.

PISCES.*

[Nomenclature: DAY, *British Fishes.*]

COTTUS, sp. A specimen is recorded by Mr. Todd from the zostera south of Pilworthy Point. The specimen was not kept, so that the species is uncertain. Several were also obtained under the Marine Hotel.

GOBIUS PAGANELLUS, *Gmel. Linn.* Taken in zostera under the Marine Hotel and on the eastern side of Kingsbridge estuary.

GOBIUS RUTHENSPARRI, *Euphr.* Abundant in the zostera and along the shore at all points (under the Marine Hotel, Snape's Point, mouth of Southpool Lake, Salstone).

Goby larvæ, from 2·5 to 5·5 mm. in length, probably referable to this species, were taken abundantly in tow-nets between Snape's Point and Ditch End, August 7th to 12th.

APHIA PELLUCIDA, *Nardo.* One young specimen, 12 mm. in length, was taken in zostera under the Marine Hotel on July 14th. It resembles the adult female in general features, but is slightly more slender in form and still scaleless. For observations on the habits of this species in Plymouth Sound see this Journal, v. pp. 89 and 338.

CENTRONOTUS GUNNELLUS (*Linn.*). Mr. Todd found one specimen on the south end of the Salstone, in an empty *Buccinum* shell.

CALLIONYMUS LYRA, *Linn.* A young specimen, 12 mm. long, was taken on the zostera bed opposite Snape's Point on June 16th.

LABRUS MACULATUS, *Bl.* Four young specimens were taken in zostera under the Marine Hotel on July 14th. Three are about one inch in length (23 to 28 mm.); the fourth is much smaller, measuring only 11·3 mm. Even at this stage the species is readily distinguishable from its congeners by the fin-ray formula of the dorsal and anal fins, which for all four specimens was as follows:—

D. XX.—XXI; 10–11. A. III; 9–10.

The last two soft rays of each fin have been counted as one, in accordance with Günther's method. From *C. melops* of the same size the youngest specimen is also distinguishable by the uniform distribution of the chromatophores on the sides of its body, as far back as the hinder margin of the dorsal and anal fins, where they cease (cf. *Ct. rupestris*, Holt, Ann. Mus. Marseille, v., 1899, pl. 5, fig. 49).

CRENILABRUS MELOPS, *Linn.* Very young specimens, from 7·7 to 11·5 mm. in length, were taken in large numbers in the zostera under the Marine Hotel on July 14th. A larger specimen, measuring 20 mm., was taken in zostera at the mouth of Southpool Lake on August 8th. The species is distinguishable at all these stages from its allies, not only by its fin-ray formula, but also by the vertical stripes produced by the grouping of the chromatophores. The latter, in specimens below 12 mm. in length, do not extend behind the hinder margin of the dorsal and anal fins (cf. *Ct. rupestris*, Holt, Ann. Mus. Marseille, v., 1899, pl. 5, fig. 49), but are already grouped into four or five vertical bands, separated by intervals devoid of chromatophores. In the smaller specimens (8 to 10 mm.) the bands are less distinct than in the larger ones, but their incipient formation is indicated by the gaps visible here and there among the chromatophores. At first the gaps appear somewhat irregular, owing to their independent development along the uppermost and middle regions of the side; but at about 10 mm. the dorsal and mid-lateral gaps begin to coalesce in a vertical direction, and thus produce more definite interspaces between the bands. The latter are best defined, as a rule, near their dorsal ends. Each band, in specimens 8 to 11 mm. long, contains about four to five chromatophores in a line drawn across its breadth; but this number increases considerably as growth proceeds, since the bands in the largest specimen (20 mm.) contain from 12 to 20 chromatophores across. The number of fin-rays in the ten specimens counted fell within the formula—

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* By W. GARSTANG and L. W. BYRNE.

D. XVI; 8-9. A. III; 9–10.

Only in the smallest specimen (below 8 mm.) was it impossible to determine the number of dorsal rays.

It should be added that these young wrasses below 12 mm. in length (whether *C. melops* or *L. maculatus*) still retain remnants of the larval fin membrane in the preanal region ventrally, and in front of the caudal fin both dorsally and ventrally.

CENTROLABRUS EXOLETUS, *Linn.* One young specimen, 36 mm. in length, was found in zostera opposite the Marine Hotel, August 19th.

GASTEROSTEUS SPINACHIA, *Linn.* One specimen, south of Pilworthy Point.

SYNGNATHUS, sp. A young, recently liberated specimen was taken in a tow-net off Snape's Point, on August 13th.

NEROPHIS ÆQUOREUS, *Linn.* Under Marine Hotel.

ATHERINA PRESBYTER, *Jenyns.* Abundant along the wharves.

CLUPEA SPRATTUS, *Linn.* Four sprat larvæ, varying between 14·5 and 18·25 mm. in length, were taken in tow-nets at night between Snape's Point and Ditch End, August 7th to 13th.

Six young sprats, 29·5 to 34·8 mm. in length, were taken at the surface on July 16th in the harbour. They formed part of a shoal which was being pursued, according to the fisherman, by atherines.

APPENDIX.

NOTES ON THE SEINE AND TRAMMEL FISHING IN SALCOMBE HARBOUR DURING 1900.

The following tables have been compiled from information kindly placed at our disposal by Mr. J. Luskey Coad, of Salcombe. They provide a record of the results of each day's fishing during the season with a seine and a trammel-net inside the harbour. The seine hauls were made at various points in the estuary; the trammel net, on the other hand, was always shot just inside the harbour bar.

The season, as may be inferred from the tables, was not a very good one, the most notable catch being that of twenty bass, averaging 1½ lb. weight, in the trammel on September 17th. Mr. Coad remarks that the trammels shot by other boats outside the harbour did well with red mullet. Later in the year (October) mackerel became exceptionally plentiful, many boats averaging one hundred each on the morning of October 17th. The first mackerel taken by Mr. Coad during the season was caught while whiffing off Gammon Head on the 9th of May.

Although the seine yielded a moderate number of plaice and flounders during August and September, we met with no evidence that the estuary is to any extent a nursery for young flatfish, the absence of which from the muddy foreshores was a marked feature.

In explanation of the term "Hud," which is once used in the first table, Mr. Coad adds that the creature is "an ink fish, similar to the squid, of a brownish green colour." He identifies it with the genus *Ommastrephes*, and states that the specimens caught this year averaged from about 6 to 12 inches in length. The squid (*Loligo*) caught this year varied between 3 and 14 inches in total length.

W. G.

I. SEINE-NET.

	JUNE	JULY			AUGUST				SEPTEMBER			Total.
	29	16,	27,	30	10,	13,	25,	28	7,	25,	28	
Bass	3	4	1	3	—	1	2	—	1	—	—	15
Red Mullet . .	—	—	2	—	—	—	8	1	—	—	6	17
Gurnards . . .	—	—	—	—	—	—	—	—	2	—	2	4
Mackerel . . .	—	—	—	—	—	—	—	—	—	—	1	1
Dory	—	—	1	3	8	3	6	—	4	3	1	29
Sand Smelt . .	Many	—	Many	—	—	—	—	—	25	—	25	Many
Grey Mullet . .	—	—	—	2	—	—	—	—	—	—	—	2
Conners and Wrasse*.	—	6	Many	—	Many	—	—	—	—	—	—	Many
Pollack . . .	2	—	6	—	12	12	12	160	6	12	10	232
Plaice . . .	—	3	4	5	10	18	12	3	1	3	4	63
Flounder . . .	—	4	—	—	12	12	14	12	2	12	—	68
Sole	—	—	—	—	—	1	—	—	—	2	1	4
Lobster . . .	—	—	2	—	—	—	1	1	—	—	—	4
Spider Crabs . .	—	—	—	—	—	—	—	—	2	—	—	2
Squid . . .	—	—	—	—	—	—	—	—	2	—	—	2
Hud	—	—	—	—	—	—	—	—	1	—	—	1
Octopus . . .	—	1	—	—	5	—	—	—	12	—	—	18
Total Fishes . .	5+?	17	14+	13	42+	47	54	176	41	32	50	

* *Crenilabrus melops* and *Labrus maculatus.*

II. TRAMMEL-NET.

	JULY					AUGUST									SEPTEMBER									Total.
	4,	6,	7,	19,	20	7,	8,	9,	18,	19,	20,	21,	30,	31	1,	4,	5,	6,	17,	18,	19,	20,	21	
Bass . .	—	—	—	—	—	—	—	—	1	—	—	—	7	1	4	—	2	—	20	1	1	—	—	37
Red Mullet .	—	—	—	—	—	—	—	—	—	—	3	—	—	1	1	—	3	—	1	2	—	—	—	11
Gurnard .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Mackerel .	—	—	1	—	1	—	—	—	—	1	1	—	—	—	—	3	—	—	—	—	—	—	—	7
Dory . .	—	—	1	—	2	—	—	4	7	1	3	1	—	2	—	2	1	5	—	—	2	—	—	31
Grey Mullet	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	2	1	—	—	—	—	—	5
Wrasse * .	2	1	2	1	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	1	—	—	9
Cod . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Pollack .	1	1	1	2	—	—	—	2	1	1	—	2	—	—	—	—	2	1	—	—	—	—	—	14
Pouting .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2
Rockling .	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Brill . .	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	3
Plaice . .	4	—	—	—	—	2	2	—	—	—	1	—	—	—	—	—	—	—	2	—	—	4	2	17
Flounder .	1	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
Sole . .	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	2	1	3	1	9
Peal . .	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Ray . .	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	2	—	5
Lobster .	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Crab . .	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Spider Crab.	M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	Many
Total Fishes	9	5	5	4	4	2	7	6	10	4	8	3	7	4	5	6	15	7	23	5	5	9	6	

* *Labrus maculatus* alone.

The Amphinomidæ, Aphroditidæ, Polynoidæ, and Sigalionidæ of Plymouth and the English Channel.

By

T. V. Hodgson.

HAVING attempted to investigate the Polychæte fauna of the Plymouth district during those favourable opportunities which have occurred during the past three years, I now put upon record some few notes respecting a small section of this interesting but extremely perplexing group.

The section under consideration is that treated of by McIntosh in his recently published Monograph (20). I have taken advantage of that work to compile a synoptical table of the British species belonging to those genera which are represented in the English Channel.

The attention that I have been able to give to these Polychætes has not been what I could have wished, nor has it been anything like adequate to exhaust the local species. I might therefore publish a very incomplete list, or, by bringing into a compact form the records of those species known to occur in the Channel in addition to a synoptical table, I might be able to assist some future worker. I have adopted the latter alternative. The synopsis has been difficult to prepare, and that difficulty has not been diminished by a complete ignorance of many of the species included. Many are known only from single or even mutilated specimens which have been obtained from the stomachs of fishes.

One is rarely satisfied with definitions, generic or specific, and this dissatisfaction becomes the more pronounced when comparisons have to be made. In adopting the classification of McIntosh an awkward situation presents itself. The genus Polynoë, after undergoing numerous fluctuations, has, for the time at least, been divided into a number of small but closely related genera. There are nine of these included in the British fauna, distinguished by the possession of fifteen elytra. De St. Joseph, in his *Annélides Polychètes des côtes de Dinard*, unites four of these genera with others; thus Harmothoë, Eunoa, Evarne, and Antinoë are included in the single genus Harmothoë. I have allowed the four new species described by that author to remain in the genus Harmothoë without attempting to reduce them to the smaller genera of McIntosh, it being, in a paper of this kind, a matter of small importance. In dividing the genus Harmothoë into three sections, I have relied largely upon the accuracy of McIntosh's drawings.

In the following synopsis the family and generic descriptions are copied from McIntosh (20), with a slight alteration of terminology and omission of all points relating to internal anatomy.

The local area included in the scope of this paper is the entire south coast of Devon and Cornwall. The field thus defined is a large one, and has not by any means been exhaustively worked. The central area in the immediate vicinity of Plymouth is best known, and as the operations of the Marine Biological Association extend east and west, so the more likely and productive spots will be first visited, and the intervening areas will receive attention in due course. The varied character of the shores round Plymouth renders it a particularly rich spot for Polychætes. Extensive mud-flats occur in all the rivers, and the shore in the Sound possesses numerous areas strewn with fucoid-covered boulders and stones, with or without muddy sand, in large patches. These form productive grounds for numerous species, the richest and best of which are Drake's Island, Rum Bay, the Bridge, and Bovisand Bay.

Below tidal water Millbay Channel is, perhaps, the richest field. The bottom there is covered with stones of varied character, rough and smooth, usually bored by Saxicava and other boring animals. These form the home of numerous hydroids, sponges, etc.

Queen's Ground and Duke Rock are cleaner and yield irregular clinkers from the ocean steamers, with shell detritus, all of which are more or less covered with hydroids, polyzoa, and algæ, etc.

Outside the Sound, Wembury Bay is a favourite ground, and exhibits every phase, from huge fucoid-covered boulders, stones, to muddy sand and fine sand; and though its area is not particularly large, its varied character renders it exceptionally productive.

The varied character of the bottom offshore has been indicated in a remarkably precise manner by Allen, in his paper "On the Fauna and Bottom-Deposits near the Thirty-Fathom Line from the Eddystone Grounds to Start Point."

The fauna of Salcombe Harbour has recently been investigated by Mr. Allen and Mr. Todd with interesting results as regards Polychætes, and I am indebted to them for the opportunity of including those species here, and further to the latter gentleman for giving me other notes, which are distinguished by his initials.

Throughout the paper I have marked with an asterisk (*) all those species which are known to occur in the local area as already defined. All those forms occurring elsewhere in the Channel are distinguished by a dagger (†).

FAMILIES.

AMPHINOMIDÆ.

Body elongate, or more or less ovoid.

Parapodia much modified, the neuro and notopodia widely separated, the latter merged in the dorsum and provided with chætæ, branchiæ, and cirri.

APHRODITIDÆ.

Body comparatively large, ovate or oblong.

Chætæ very strong. Parapodia bearing fifteen elytra, which are sometimes concealed by a dense felt.

POLYNOIDÆ.

Body more or less elongate, usually comparatively broad, more or less concealed by a variable number of elytra.

Prostomium, with four sessile eyes and three tentacles.

ACOETIDÆ.

Body elongate, partially concealed by numerous elytra.

Prostomium, with pedunculate eyes and three tentacles.

SIGALIONIDÆ.

Body elongate, concealed by numerous elytra, which are accompanied by a cirriform gill. Ctenidia on all parapodia.

FAMILY **AMPHINOMIDÆ.**

Prostomium rounded or compressed. A median and two lateral tentacles, though the latter may be absent, an elongated dorsal caruncle, and four eyes.

Body elongate, oblong or ovate oblong, feet with the noto and neuropodia widely separated and furnished with cirri.

Mouth removed from the tip of the snout ventrally, with modified segments laterally; protrusible proboscis devoid of jaws.

Parapodia peculiarly modified, the notopodium being extended and merged into the dorsum, but with chætæ, branchiæ, and cirri. Chætæ brittle, calcareous, and tubular, with gelatinous contents; rarely hook-like spines.

Buccal apparatus and proboscis large and complex.

Anus dorsal, with two posterior appendages.

SUB-FAMILY I. AMPHINOMINA.

Body elongate. A median and two lateral tentacles. Noto and neuropodia widely separated.

GENUS PARAMPHINOME.

Prostomium small. No caruncle, no eyes. Five tentacles.

Branchiæ on anterior segments only.

Genus Eurythoë.

Prostomium large. A caruncle, four eyes, dorsal. A median and two lateral tentacles.

Branchiæ from the third segment backward.

Sub-Family II. EUPHROSYNINA.

Body oblong or ovate oblong. A median tentacle, a trilobed caruncle.

Genus Spinther.

Prostomium merged into general contour of body. Eyes four, at base of tentacle.

No branchiæ.

Genus Euphrosyne.

Prostomium narrow. Eyes four, two dorsal and two ventral.

Notopodium merged into the dorsum and provided with several arborescent branchiæ, and two or three dorsal cirri on each side.

Genus EURYTHOË, *Kinberg.*

Body elongated, with flattened rectangular segments.

Prostomium large, rounded or pentagonal. Eyes four, dorsal. A median and two lateral tentacles. Caruncle trilobed.

Palpi forming two adnate lobes inferiorly in front of the mouth, each with a tentacular process or stylode.

Dorsal cirrus single. Chætæ of the notopodium linear, sub-articulate; others sub-bifid, with a serrate limb and a short process. Neuropodial chætæ bifid.

Branchiæ from the third segment backward.

†Eurythoë borealis, *Sars.*

Genus EUPHROSYNE, *Savigny.*

Body generally short, oblong, equally narrowed at either end. Segments not numerous, two thick styles posteriorly.

Prostomium narrow, frontal part narrowest, a band passing downward to the inferior ridge. Eyes both on the dorsal and ventral surfaces. One median tentacle situated in front of eyes. Lateral tentacles two, very short, springing in front of the inferior eyes.

Fascicles of chætæ arranged on each side of the segments. Notopodial chætæ forming a transverse row, no barbs. Neuropodial chætæ grouped in a broad pencil. Capillary chætæ unequally bifurcate. Dorsal cirri two (or three, Ehlers) on each side, one at the inner border of the fascicle, the other at the outer margin. Ventral cirri single.

Branchiæ dorsal, in rows, and more or less ramose.

Palpi forming fixed lobes on each side of the mouth.

Mouth opening on the ventral surface and extending over several segments.

Buccal apparatus complex.

*E. FOLIOSA, *Aud. et Edw.* Size nearly 1 inch.

Branchiæ with ovate expansions at the tips.

E. ARMADILLO, *Sars.* Size ⅓ inch.

Branchiæ with lanceolate tips.

E. ROBERTSONI, *McIntosh.* Size ½ inch.

Branchiæ with digitate tips, only a trace of a swelling.

†E. INTERMEDIA, *St. Joseph.*

As *E. foliosa,* with a bundle of chætæ between noto and neuropodia.

FAMILY **APHRODITIDÆ.**

Annelids of an ovate or oblong form, convex dorsally, with a distinct prostomium, on which are a pair of eyes and a median tentacle, and under which is a papillose facial tubercle.

No lateral tentacles, two palpi. Tentacular cirri long, buccal cirri (ventral cirri of the second foot) moderately long.

Proboscis long and powerful, with four muscular ridges representing teeth, and a tough internal lining.

Dorsal fimbriæ small, alternating with the elytra, or absent.

First foot bearing three dense tufts of bristles.

Elytra, fifteen pairs occurring on segments 2, 4, 5, 7, 9, . . . 25, 28, 31.

Segmental organs (nephridia) opening by well-marked papillæ pointing upwards between the feet.

APHRODITA, *Linn.*

Elytra concealed by a close felt of simple hairs.

Eyes sessile. All chætæ simple.

LÆTMATONICE, *Kinberg.*

Elytra concealed by a close felt of simple hairs.

Eyes on short peduncles.

Chætæ of the elytra-bearing feet glochidiate.

HERMIONE, *Blainville.*

No dorsal felt. Eyes pedunculate.

Elytra alternating with dorsal cirri.

Chætæ simple, glochidiate, and bidentate.

Genus APHRODITA, *Linnæus.*

Eyes sessile.

Dorsum covered with a thick, close felt of massive, simple hair. Chætæ of the neuropodium long, silky, and iridescent, and like all other chætæ, simple, not barbed or toothed.

*Aphrodita aculeata, *Linn.*

Genus †LÆTMATONICE, *Kinberg.*

Eyes on short peduncles placed near the anterior border of the head.

Dorsum covered with felt.

Spines of the elytra-bearing feet glochidiate, other segments with lateral bundles of stout bristles and a tuft of hair-like chætæ. Chætæ of the neuropodium semi-pinnate.

Segmental organs (nephridia) opening externally by papillæ directed upwards between the parapodia.

†L. filicornis, *Kinberg.*

Prostomium tripartite.

Glochidiate chætæ with three or four teeth.

L. producta, *var. Britannica, McIntosh.*

Prostomium triangular. Ocular peduncles present, but no eyes.

No dorsal felt.‡

Glochidiate chætæ with four recurved fangs, besides the process at the base of the terminal spear-tip.

Genus HERMIONE, *Blainville.*

Prostomium, with a single tentacle and two palps.

Peristomium bears chætæ and two long cirri.

Pedunculated eyes fixed to the margin of the prostomium.

Maxillæ absent or small.

No dorsal felt. Elytra alternating with dorsal cirri.

Neuro and notopodial divisions of the feet distinct.

Elytra-bearing feet with glochidiate dorsal spines and a tuft of strong chætæ over the elytra. Neuropodial chætæ bidentate.

Segmental papillæ from the eighth to the twenty-ninth foot.

*Hermione hystrix, *Savigny.* Size to 2¼ inches.

Family **POLYNOIDÆ.**

Body more or less elongate.

No facial tubercle, convex prostomium; the base of the tentacle arising from the middle anteriorly. Two lateral tentacles, four eyes, palpi elongate.

‡ This is a divergence from the generic distinction.

Peristomium bearing the first foot with long dorsal and ventral cirri, and the ventral cirrus of the next segment long.

Pharynx exsertile, muscular, cylindrical, with papillæ round the margin; horny jaws.

Parapodia, first foot bearing only a few minute chætæ, conforming to the dorsal type.

Elytra, twelve to thirty-five or more; segments carrying these devoid of cirri.

Segmental organs opening ventrally on papillæ near the bases of the feet.

Dorsal chætæ with more or less tapered simple tips, ventral chætæ with simple or bifid hooked tips.

Development by trochophores.

SYNOPSIS OF GENERA.

Twelve elytra.

LEPIDONOTUS, *Leach.*

Prostomium produced into the bases of the tentacles.

Fifteen elytra, covering the body entirely.

Prostomium produced into the bases of the tentacles.

MALMGRENIA, *McIntosh.*

Tentacles, palps, and cirri smooth.

Eyes large, lateral, nearly forming a square.

Lateral tentacles arise underneath the base of the median.

GATTYANA, *McIntosh.*

Tentacles and cirri densely covered with long cilia.

Elytra smooth to the naked eye, posterior and external margin with long cilia, segmental papillæ long.

HARMOTHOE, *Kinberg, char. em.*

Posterior, pair of eyes, dorsal, anterior ventral, or on the extreme margin. Not always visible from the dorsum.

Segmental papillæ long.

Dorsal chætæ, well-marked spinous rows, smooth tips.

Ventral chætæ, simple-hooked tips, superiorly and inferiorly, median bifid.

ANTINOË, *Kinberg.*

Eyes as in Harmothoë.

Elytra, surface spinous, margin with short cilia.

Dorsal chætæ, long and tapering, well-marked spinous rows.

Ventral chætæ, long and slender, with elongated spinous regions and hair-like tips.

EUNOA, *Malmgren.*

Eyes postero-lateral or lateral.
Elytra, surface tuberculate, margin ciliate.
Dorsal chætæ, minutely spinulous, tip pointed and bare.
Ventral chætæ somewhat longer, tip smooth, hooked, spinous rows large.

EVARNE, *Malmgren.*

Eyes large, close together, postero-lateral in position.
Dorsal chætæ shorter than ventral, spinous rows large.
Ventral chætæ very long, with minutely bifid tips.

PHYLLANTINOË.

Cephalic appendages and elytra unknown.
Prostomium short and broad, median tentacle arising far backwards between the lobes. Eyes postero-lateral.

Fifteen elytra, not completely covering the body. About 40 segments.

LAGISCA, *Malmgren.*

Body narrow and attenuate posteriorly.
Last 9–12 segments not covered by elytra.

SCALISETOSUS, *McIntosh.*

Elytra cover dorsum in front, but leave it uncovered posteriorly. Translucent.

Fifteen elytra, on anterior part of body only. About 100 segments.

POLYNOË, *Savigny.*

Palps, with dense rows of clavate papillæ.
Elytra, with broad belt of papillæ on anterior surface.

ENIPO, *Malmgren.*

Palps and tentacles smooth.
Elytra smooth, subcircular.

Eighteen elytra.

ACANTHICOLEPIS, *Norman MS.*

Elytra coarsely spinous, covering dorsum entirely.
Prostomium cleft to form two pointed lobes.
Tentacles and cirri ciliate.

HALOSYDNA.

Elytra large, soft, with frilled outer border.
Prostomium continuous, with tentacles; these and palps smooth.
Nuchal collar with prominent flaps.

Numerous elytra. On segments 1, 3, 4, 6, . . . 25, 28 *et seq.* to end of body.

ACHOLOË, *Claparède.*

Elytra entirely covering the body.

A T-shaped branchial process on the cirriferous parapodia.

LEPIDASTHENIA, *Malmgren.*

Elytra not covering the body, except in very young specimens. Notopodium rudimentary.

GENUS LEPIDONOTUS, *Leach.*

Body short, more or less linear. Anterior part of prostomium produced into the bases of the median and lateral tentacles. Palpi smooth or with papillæ in five longitudinal rows. Elytra, twelve pairs, covering the dorsum entirely and occurring on segments 1, 3, 4, 6, 8 *et seq.* alternately.

*L. SQUAMATUS, *Linn.* Size about 1 inch or more.

Elytra entirely covering the body, conspicuously ciliate on outer and posterior margin.

*L. CLAVA, *Mont.* Size 2 inches or more.

Elytra not covering the body, except in young specimens; to the unassisted eye not ciliate.

GENUS MALMGRENIA, *McIntosh.*

Head somewhat pyriform, with the narrow end in front,‡ the median and lateral tentacles springing from the front, as in Lepidonotus. Eyes large, nearly forming a square.

Palpi, tentacles, and cirri smooth.

Segmental eminences fairly developed, but without papillæ.

Elytra, fifteen pairs, smooth, with the exception of a small group of papillæ at the anterior curve.

Dorsal chætæ translucent, short, and with faint spinous rows.

Ventral chætæ translucent, with rather short distal regions, and five rows of spines. The tip hooked, and a secondary process beneath.

*M. CASTANEA, *McIntosh.* Size $\frac{3}{4}$ inch.

Elytra smooth. Reniform examples, with a small and somewhat triangular group of papillæ near anterior curve.

Variously bordered with madder-brown.

M. ANDREAPOLIS, *McIntosh.* Size 1 inch or more.

Elytra smooth. Reniform examples, with a belt of microscopic papillæ along anterior border. A brown ring, more or less complete, on the anterior, and after the sixth and seventh becoming a V-shaped mark with a spot.

‡ McIntosh's figures do not indicate this.

Genus GATTYANA, *McIntosh.*

Lateral tentacles arising below the base of the median, they and the cirri densely covered with long cilia. Palpi, with numerous short clavate papillæ truncate at the tip.

Elytra, fifteen pairs, minutely spinous, covering all the dorsum and attached to segments 1, 3, 4, 6, 22–5 *et seq.*

This genus has only recently been instituted by McIntosh on the ground of priority, the better-known name of Nychia being already appropriated.

*Gattyana cirrosa, *Pallas.* Size nearly 2 inches.

Genus HARMOTHOË.

Body not much elongated.

Lateral tentacles fixed below the median.

Palpi, with rows of minute truncate papillæ.

Eyes four, two on the lobes in front, the two posterior on the dorsum in front of the collar.

Elytra, fifteen pair, covering the whole of the dorsum.

Segmental papillæ long. Papillæ of proboscis $\frac{9}{9}$.

1. Lateral tentacles distinctly shorter than the prostomium.

(*a*) Posterior eyes not in contact with nuchal border.

Four eyes, visible from the dorsum.

*H. marphysæ, *McIntosh.* Size about $\frac{3}{4}$ inch.

Prostomium deeply cleft, lobes somewhat rounded. Eyes small.

Elytra rather thin, smooth, and pellucid. A belt of small papillæ (spines) in front of scar.

†H. maxillospinosa, *St. Joseph.* Size nearly $\frac{3}{4}$ inch.

Prostomium, with small, narrow cleft.

Median tentacle on a very broad base.

Jaws bristling with chitinous spines.

Two eyes, visible from the dorsum.

H. antilopis, *McIntosh.* Size nearly 1 inch.

Prostomium somewhat deeply cleft, lobes subconical.

Elytra having long cilia on the outer border.

†H. picta, *St. Joseph.* Size 1 inch.

Prostomial cleft widely V-shaped.

Three tentacles, papillose, subulate, on stout dark brown bases.

(*b*) Posterior eyes in contact with nuchal border.

H. zetlandica, *McIntosh.* Size about $\frac{1}{2}$ inch.

Prostomial cleft broad, not very deep.

Elytra, with a few minute papillæ, though apparently smooth.

†H. Ljungmani, *Malmgren.* Size ½ inch or little more.
Prostomial cleft deep, not very broad.
Elytra fairly uniformly papillose, a very few minute cilia on margin.

2. Lateral tentacles about the length of the prostomium.

Four eyes, visible from the dorsum.

*H. lunulata, *Delle Chiaje.* Size about ¾ inch.
Prostomium deeply cleft, lobes somewhat rounded.
Elytra finely veined, margin smooth, a cluster of fine spines in front of scar.

*H. spinifera. Size nearly 1 inch.
Prostomium elongate, deeply cleft, lobes subconical.
Elytra, the first light-coloured, the second nearly black, the remainder becoming lighter. Spinose near the outer border, where a few clavate cilia exist.

*H. setosissima, *Savigny.* Size to 1¾ inches.
Prostomium broad, somewhat deeply cleft, lobes rounded.
Elytra densely covered with minute papillæ, a few clavate cilia on outer border.

*H. areolata, *Grube.* Size ¾ inch.
Prostomial cleft somewhat deep, wide, a slightly curved V-shape.
Elytra leathery, marked in irregular polygonal areas.
Posterior and outer margin with long cilia.

†H. cæliaca, *St. Joseph.* Nearly ¾ inch.
Prostomium broad. Tentacles and cirri with long tapering papillæ. Eyes postero-lateral.

†H. arenicolæ, *St. Joseph.* Size 1 inch.
Prostomium nearly quadrangular, the anterior border with small semicircular depression in the centre.
Three tentacles finely papillose, subulate.

3. Lateral tentacles distinctly longer than the prostomium.

H. Frazer-Thomsoni, *McIntosh.*
Four eyes, visible from the dorsum.
Elytra, margin smooth.

*H. imbricata, *Linn.* Size to 2 inches.
Posterior eyes, only visible from the dorsum.
Elytra, margin with small clavate cilia.

† H. RETICULATA, *Claparède.* Size nearly 1 inch.

Elytra marked with black spots, margin richly ciliate.

Median tentacle 2½ times the length of the lateral.

H. HALIAËTI, *McIntosh.*

No perfect specimen known.

† H. TORQUATA. *Claparède.* Size ½ inch.

Sixteen elytra. Margin smooth, except the first four.

† H. SARNIENSIS, *Lankester.* Size to 2 inches.

Twenty elytra. Lateral tentacles as long as prostomium, median tentacle three times as long.

GENUS EUNOA, *Malmgren.*

Lateral tentacles arising under the median, below and slightly internal to the peaks of the head. Palpi, with six rows of short cilia. Eyes large, visible from the dorsum.

Elytra, fifteen pairs, occurring on segments 1, 3, 4, 6, . . . 22, 25, etc. External aperture of the segmental organs indicated by blackish pigment. No papillæ. ‡

*E. NODOSA, *Malmgren.* Size 2¼ inches.

Prostomium cleft to half its length.

Eyes four, large, lateral, the anterior about the level of a median transverse line.

E. TRITONI, *McIntosh.* Size nearly 1½ inches.

Prostomium cleft to form two minute lobes.

Eyes four, moderate size, equal, the four median as regards length.

GENUS EVARNE, *Malmgren.*

Body rather small, ovate oblong, attenuate posteriorly.

Lateral tentacles fixed under the median, prostomium deeply incised in front, and with prominent lateral peaks.

Eyes four, generally large, the anterior pair on the projecting lateral region, the posterior in front of the nuchal collar and widely separated.

Palpi densely covered with minute papillæ.

Elytra, fifteen pair, spinulose, ciliated or smooth at the edge.

Dorsal bristles shorter than the ventral, and with wide rows of spines; ventral bristles very long, with minutely bifid tips.

Segmental papillæ well marked, but not long.

*E. IMPAR, *Johnston.* Size 1 inch.

Elytra, with densely ciliated margin. More posterior portion papillose, often increasing to spines, *and on the border* large pyriform or globular papillæ.

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‡ Segmental papillæ are described by McIntosh for both the species assigned to this genus.

E. JOHNSTONI, *McIntosh.* Size nearly $\frac{1}{2}$ inch.

Elytra, margin with few long and somewhat fusiform cilia.

Surface, with rather large conical horny papillæ, often with blunt spinous tips.

E. HUBRECHTI, *McIntosh.* Size $\frac{1}{2}$ inch and over.

Elytra thin but tough, margin smooth, surface minutely granular under a lens.

E. ATLANTICA, *McIntosh.*

Elytra unknown.

Specimen imperfect, resembling *E. impar.*

E. PENTACTÆ, *Giard.*

Elytra resembling *E. impar.* Median tentacle only half as long again as lateral. Two dark bands on tentacular cirri.

GENUS LAGISCA.

Body rather narrow, attenuate posteriorly.

Prostomium cleft. Lateral tentacles attached below the median.

Eyes four, lateral, two just in front of a median transverse line, two in front of the nuchal border.

Elytra fifteen, covering the dorsum except the last few.

Notopodial chætæ, with acute tips and finely serrated.

Neuropodial chætæ, simple superiorly and inferiorly, rest bidentate, the rest with long spinous rows.

Papillæ of proboscis $\frac{9}{9}$.[‡]

Nephridial papillæ beginning as a minute process on the fifth foot and extending nearly to the last. Much smaller than in Harmothoë.

*L. FLOCCOSA, *Savigny.* Size about $1\frac{1}{2}$ inches.

Prostomium deeply cleft.

Elytra, most of the surface minutely and densely spinulose, and soft globular papillæ near posterior margin. Outer margin with a few short slender cilia.

L. ELIZABETHÆ, *McIntosh.* Size $\frac{1}{2}$ inch, or rather more.

Prostomium, with shallow crescentic depression separating lobes.

Elytra resembling those of *L. floccosa*, but with external margin richly provided with long clavate cilia, which become reduced posteriorly.

L. JEFFREYSII, *McIntosh.* Size nearly $\frac{3}{4}$ inch.

Prostomium somewhat deeply but narrowly cleft.

Elytra, most of the surface minutely and densely spinulose. External margin with long filiform cilia.

[‡] McIntosh figures $\frac{8}{8}$ papillæ for the proboscis of *L. floccosa.*

*L. EXTENUATA, *Grube.* Size 1¼ inches.

Prostomium somewhat deeply cleft.

Elytra, most of the surface minutely and densely spinulose. External margin richly provided with long pellucid cilia.

*L. RARISPINA, *Malmgren.* Size 1½ inches.

Closely resembling *L. floccosa.* Spines on elytra larger.

Two curved chætæ arise dorsally from the base of the tentacular cirri.

GENUS SCALISETOSUS, *McIntosh.*

Anterior border of the head smoothly rounded.

Eyes placed close together on each side, while the right and left pairs are widely separated and placed far back.

Palpi smooth. Proboscis somewhat thin.

Body of moderate length. Scales cover the dorsum in front, but leave the centre bare posteriorly.

Segmental eminence distinct, but papillæ small.

Chætæ transparent as crystal; dorsal slightly curved, and with from five to eight very distinct rows of spines. Ventral bristles slender, elongate, with close spinous rows, and hooked and bifid tip.

†S. COMMUNIS, *Delle Chiaje.* Size ¾ inch.

Median and lateral tentacles long, with numerous short clavate cilia.

*S. ASSIMILIS, *McIntosh.* Size ¾ inch.

Median tentacle long, lateral short; all smooth.

A blackish brown median band down the back.

†S. ECHINI, *Giard.* Size 1¼ inch.

Resembling *S. assimilis.* An irregular band of green down the back.

GENUS POLYNOË, *Savigny.*

Head elongated antero-posteriorly, with a somewhat indistinct peak on each side, beneath which is the lateral tentacle.

Anterior and posterior eyes widely separated.

Palpi, with dense rows of clavate papillæ.

Body linear elongate, with many segments.

Segmental papillæ long.

Elytra, fifteen pairs, with a broad belt of papillæ on the surface anteriorly.

Notopodium minute, with small spinous chætæ truncated at the tip.

Neuropodium has a single, strong, hastate chæta superiorly, and below, strong bifid chætæ with short spinous regions.

*POLYNOË SCOLOPENDRINA, *Savigny.* Size to 5 inches.

GENUS HALOSYDNA, *Kinberg.*

Body linear oblong; head continuous anteriorly with the bases of the median and lateral tentacles.

Eyes large. Palpi smooth. Nuchal collar with a prominent flap.

Segmental eminences distinct and the papillæ long.

Proboscis, with twenty-two frilled papillæ along each border.

Elytra, eighteen pairs, large, soft, and with a frilled outer border, not covering the dorsum.

Notopodium minute, with slender, simple, and finely spinous chætæ.

Neuropodium rather long, with numerous somewhat slender chætæ with tips of varying breadths.

*HALOSYDNA GELATINOSA, *M. Sars.* Size to 3½ inches.

GENUS ACHOLOË, *Delle Chiaje.*

Head elongated from before backward and running into the bases of the tentacles.

No peaks. Four large, equidistant eyes. Palpi smooth and short.

Body sublinear, flattened; segments numerous.

A segmental eminence, but no distinct papilla.

Cirri on every foot, and a T-shaped branchial process.

Elytra numerous.

Parapodia short, notopodium minute, chætæ few and small, with a minute hook at the tip. Neuropodium bearing chætæ with long and strong shafts and short spinous regions having a sharp hook at the tip.

*ACHOLOË ASTERICOLA, *Delle Chiaje.* Size to 2 inches or more.

GENUS LEPIDASTHENIA, *Malmgren.*

Corpus elongatum, sublineare depressum.

Oculi 4, utrinque bini approximati, laterales, par anterius in vel pone medium lobi cephalici.

Antennæ una cum tentaculo e parte anteriore lobi cephalici productæ.

Elytra minuta posteriora versus magnitudine decrescentia, maximam partem dorsi nudam relinquentia, in segmentis pedibus instructis 1, 3, 4, 6, 8, . . . 20, 22, 25, 28, . . . 79–82 obvia.

Ramus superior pedis perminutus acicula sola prædítus, setis omnino carens. Setæ rami inferioris infra apicem subrectum bidentatum, dentibus subrectis, paullo dilatatæ serrulatæ; 1 l. 2 superiorum ceteris plerumque duplo validiores et crassiores apice integro, margine altero vero dentibus paucis serrato.

Cirri anales 2 breves pone anum dorsualem. [*Malmgren.*]

*LEPIDASTHENIA ARGUS, *sp. nov.* Size to 8 inches (see p. 250).

Family **SIGALIONIDÆ.**

Prostomium rounded, often with a nuchal collar posteriorly.

No facial tubercle. Median tentacle, when present, generally long, produced from the median part of the prostomium and with ctenidia at the sides of the base (ceratophore).

Lateral tentacles fused with the base of the tentacular cirri, the tips only emerging.

Eyes four, occasionally only two, or absent.

Palpi long, attenuate, and smooth, with buccal ctenidia at the bases.

Body long and narrow.

Pharynx, with $\frac{9}{9}$, $\frac{11}{11}$, $\frac{13}{13}$ papillæ and teeth.

First pair of feet carried in front of the head.

Notopodial chætæ spinous and tapering.

Neuropodial chætæ compound, the terminal region being often long, multiarticulate, and bifid.

Ctenidia on all the feet.

Elytra and cirriform gills alternate in the anterior segments up to the twenty-sixth; those of the middle and posterior part furnished with both elytra and cirriform gills.

STHENELAIS, *Kinberg.*

Elytra partly fringed with a variable number of minute papillæ, entirely covering the dorsum.

EUSTHENELAIS, *McIntosh.*

Elytra unknown. Known only from a fragment.

SIGALION, *Aud. et Edw.*

Elytra partly fringed with pinnate processes, or with long papillæ arising from an axis; entirely covering the dorsum.

LEANIRA, *Kinberg.*

Elytra not covering the dorsum anteriorly, smooth in outline and surface.

A median and two lateral tentacles.

PHOLOË, *Johnston.*

Elytra partly fringed with long cilia with moniliform tips. Median portion of dorsum exposed.

A median tentacle only. Two pair of eyes.

Genus STHENELAIS.

Prostomium rounded anteriorly, with a nuchal collar posteriorly in the preparations.

A pair of ctenidia at the base (ceratophore) of the median tentacles.

Lateral tentacles fused with the first foot; tentacular cirri more or less separate.

Palpi long, subulate and smooth, springing from the ventral surface of the prostomium, but fusing with the first foot.

A pair of scoop-shaped ctenidia at the base.

Elytra covering the dorsum, fringed.

Noto and neuropodia of equal lengths.

Segmental eminence at the base of each foot, and a ciliated funnel-shaped process on the foot.

A well-developed branchial process on every foot, and on the dorsal ridge beneath it three T-shaped ciliated organs.

Notopodial chætæ long, stiff, finely tapered, and spinous.

Neuropodial chætæ, upper ones with simple tips, boldly spinous; next come compound bristles at first, with a terminal region of three segments, then with one joint, and at the ventral edge with one to four joints, all with bidentate tips. They are arranged in the foot after the outline of a horseshoe, in transverse section.

*S. BOA, *Johnston.* Size to 8 inches.

Prostomium, with broad, crescentic depression on the anterior border. Eyes four, antero-lateral in position; the anterior, the largest, are almost hidden by the ctenidia.

S. ZETLANDICA, *McIntosh.* Size 2 inches and more (?).

Specimen fragmentary. Head unknown.

†S. ATLANTICA, *McIntosh.* Size unknown.

Prostomium divided into two lobes by a slight median depression. Median tentacle subulate and with a terminal joint. Eyes four, one behind the other in the middle of the anterior border of each lobe.

*S. LIMICOLA, *Ehlers.* Size 2 inches and more.

Prostomium ovoid laterally, base of median tentacle large and cylindrical (conical in spirit), eyes four, posterior just behind base of median tentacle, the anterior usually concealed by the ctenidia.

S. JEFFREYSII, *McIntosh.* Size 2 inches (?).

Prostomium broadly ovate, bearing a long median tentacle on a short base. No eyes visible (in a preparation).

†S. MINOR, *Pruvot and Racovitza.* Size 2 inches (?).

Prostomium resembling that of *S. limicola*, but with small processes on the inner border of the ventral tentacular cirrus. In *S. limicola* they are large.

GENUS SIGALION, *Audouin and Milne Edwards.*

Prostomium elongate from before backwards.

Median tentacle absent, lateral tentacles short and papilliform, fixed to the anterior part of the prostomium.

Elytra covering the dorsum; marginal processes pinnate, or with long papillæ from the axis.

The parapodia resemble those of *Sthenelais,* notopodium clavate and furnished with a papilla. Chætæ as in *Sthenelais.* Neuropodium somewhat truncate and with a papilla internal to the chætæ, which are all bifid.

Branchiæ on every foot (*S. Matildæ*).

Segmental eminence placed ventrally at the base of each foot.

†S. MATILDÆ, *Aud. & Edw.* Size to 5 inches.

Four eyes, near the centre of the prostomium.

S. BUSKII, *McIntosh.* Eyes unknown.

GENUS PSAMMOLYCE, *Kinberg.*

Caput antenna singula et 2 aut 4 oculis; proboscis armata; primi pedes antice ultra caput porrecti, cirrus tentacularibus instructi; pedes ceteri quasi uniremes; elytra medium dorsi haud tegentia, margine fimbriato, papillis obsita. [*Carus.*]

PSAMMOLYCE HERMINIÆ, *Aud. & Ed.*

GENUS PHOLOË, *Johnston.*

Prostomium furnished with a short median tentacle.

Eyes, two pairs, more or less connate.

Body linear oblong; elytra on alternate segments in the anterior part of the body; posteriorly a pair on each segment.

First foot with two tentacular cirri, without chætæ.

Notopodium with slender, tapering, spinous chætæ.

Neuropodium with stout, falcate, compound chætæ.

P. MINUTA, *O. Fabricius.*

Tentacle and cirri somewhat papillose. Size ¾ inch.

†P. SYNOPHTHALMICA, *Claparède.*

Tentacle and cirri swollen at the base; two of the cirri papillose.

LIST OF BRITISH SPECIES, INCLUDING THOSE RECORDED FROM THE ENGLISH CHANNEL.

* Found on the coast of Devon and Cornwall.
† Found in the Channel, but not on the British Coasts.

AMPHINOMIDÆ.

AMPHINOMINA.

PARAMPHINOME, *Sars.*
P. pulchella.

EURYTHOË, *Kinberg.*
†E. borealis.

EUPHROSYNINA.

SPINTHER, *Johnston.*
S. oniscoides.
S. miniaceus.

EUPHROSYNE, *Savigny.*
*E. foliosa.
E. armadillo.
E. Robertsoni.
†E. intermedia.

APHRODITIDÆ.

APHRODITA, *Linnæus.*
*A. aculeata.

LÆTMATONICE, *Kinberg.*
†L. filicornis.
L. producta.

HERMIONE, *Blainville.*
*H. hystrix.

POLYNOIDÆ.

LEPIDONOTUS, *Leach.*
*L. squamatus.
*L. clava.
†L. pleiolepis.

GATTYANA, *McIntosh.*
*G. cirrosa.

EUNOA, *Malmgren.*
*E. nodosa.
E. tritoni.

POLYNOIDÆ.

LAGISCA, *Malmgren.*
*L. floccosa.
L. Elizabethæ.
L. Jeffreysii.
*L. extenuata.
*L. rarispina.

ACANTHICOLEPIS, *Norman MS.*
A. asperrima.

HARMOTHOË, *Kinberg.*
*H. imbricata.
*H. spinifera.
H. zetlandica.
†H. Ljungmani.
H. antilopis.
H. Haliaëti.
H. Frazer-Thomsoni.
*H. marphysæ.
*H. lunulata.
*H. setosissima.
*H. areolata.
†H. cæliaca.
†H. maxillospinosa.
†H. picta.
†H. arenicolæ.
†H. reticulata.
†H. torquata.
†H. Sarniensis.

EVARNE, *Malmgren.*
*E. impar.
E. Johnstoni.
E. Hubrechti.
E. atlantica.
†E. pentactæ.

LIST OF BRITISH SPECIES, ETC.—*continued.*

POLYNOIDÆ.

ANTINOË, *Kinberg.*
- A. Sarsi.
- A. finmarchica.
- A. mollis.

PHYLLANTINOË, *McIntosh.*
- P. mollis.

SCALISETOSUS, *McIntosh.*
- †S. communis.
- *S. assimilis.
- †S. echini.

MALMGRENIA, *McIntosh.*
- *M. castanea.
- M. andreapolis.

HALOSYDNA, *Kinberg.*
- *H. gelatinosa.

POLYNOË, *Savigny.*
- *P. scolopendrina.

ENIPO, *Malmgren.*
- E. Kinbergi.

ACHOLOË. *Claparède.*
- *A. astericola.

LEPIDASTHENIA.
- *L. argus.

ACOETIDÆ.

PANTHALIS, *Kinberg.*
- P. œrstedi.

SIGALIONIDÆ.

STHENELAIS, *Kinberg.*
- *S. boa.
- S. zetlandica.
- †S. atlantica.
- *S. limicola.
- S. Jeffreysii.
- †S. minor.
- S. sp.

EUSTHENELAIS, *McIntosh.*
- E. hibernica.

SIGALION, *Audouin & M. Ed.*
- †S. Mathildæ.
- S. Buskii.

PSAMMOLYCE, *Kinberg.*
- †P. Herminiæ.

LEANIRA, *Kinberg.*
- L. hystricis.

PHOLOË, *Johnston.*
- P. minuta.
- †P. synophthalmica.

The following species are recorded on the French coast, but I have not sufficient information to assign to them their right position:—

Polynoë lævis, *Audouin and M. Edwards.*
Lænilla alba, *Malmgren.*
Hermadion variegatum, *Gr. et Kr.*

DISTRIBUTION OF SPECIES.

†EURYTHOE BOREALIS, *Sars.*

This species has been recorded by McIntosh from under a stone in a tide pool at Herm. This author regards it as rare in British waters, but Benham (3) remarks that specimens six inches long occur all round the British area. Taking the size of the animal into consideration, it is doubtful if the two authors refer to the same species.

LOCALITY.

Herm	Tide pool	McIntosh (16).

*EUPHROSYNE FOLIOSA, *Audouin and Edwards.*

A species which is by no means uncommon. Its colour is some shade of orange-red, but this has something of a greyish character in many specimens. Those taken from Plymouth Sound are often partially concealed by a covering of flocculent detrital matter. The animal occurs in the holes of rocks and stones brought up by the dredge; it has also been found on the fine gravel of Ground XIV (1) in the neighbourhood of the Eddystone.

Of the numerous species of Polychætes described by McIntosh in his recent Monograph (20) a large number are noted as being deep-water forms in the north, but as their range of distribution passes to the south, so they make their home in shallower or even tidal waters. This species is a case in point, but I have never met with it in tidal waters.

Pruvot‡ (29) records it from the Fucus zone, the Himanthalia zone to the gravel of the base of his littoral zone.

LOCALITIES.

Plymouth: Millbay Channel, Duke Rock, Mewstone Grounds, Stoke Point.

Eddystone Ground XIV.	Fine gravel	Allen (1).
Herm	Under stones near low-water mark	(Lankester, Hornell, McIntosh) McIntosh (20).
Weymouth		Gosse, *fide* McIntosh (20).
Dinard	Dredgings and at extreme low tide, under large stones	de St.-Joseph (31).
Between Granville and Iles Chausey	Bed of oysters and Anomia	Audouin and Milne-Edwards (2).
St. Malo		Grube (12).
Côtes de Bretagne		Pruvot (29).
St. Vaast		Grube (14).

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‡ See p. 257.

†EUPHROSYNE INTERMEDIA, *St.-Joseph.*

Recorded once only from a dredging near la Conchée, Dinard, by de St.-Joseph.

McIntosh is inclined to regard this as only a variety of *E. foliosa.*

LOCALITY.

Dinard (la Conchée)	Dredging	de St.-Joseph (31).

*APHRODITA ACULEATA, *Linn.*

This, the common sea-mouse, is a well-known and widely distributed species. Though so common, it is not often taken by the Association in their dredging and trawling operations, but considerable numbers are brought into the port by the local fishermen, and some of these are of very large size.

Möbius (27), dealing with the North Sea, states that it frequents a soft bottom of mud, muddy sand, or sand and shells, shells, sand, and small stones, to a depth of 100 fathoms and over.

Pruvot (29) records it from the Himanthalia zone among seaweeds, where the bottom is sandy, on the coast of Brittany, and from coastal mud or sand of the open sea in the Golfe du Lion.

LOCALITIES.

Plymouth: Penlee, 3-6 miles S.W. (R. A. T.), Rame Head, 2–5 miles S.W. (R. A. T.), Stoke Point, Mewstone Grounds.		
Eddystone Grounds III., IV., V.	Fine sand	Allen (1).
Devon	Common all along the coast, and cast up by storms	Parfitt (28).
Folkestone and Sandgate	Beach after storms	T. V. H.
Scarriaux, Côtes du Boulonnais		A. Malaquin (21).
Wimereux		Darboux (8).
Dinard	Only among algæ brought up by the trawl	de St.-Joseph (31).
Baie de Cancale	Principally on sheltered bottoms and oyster beds. Only by accident it occurs at low tide or on the beach	Audouin and M.-Edwards (2).
St. Malo, Roscoff		Grube (12).
St. Vaast		Grube (14).

†LÆTMATONICE FILICORNIS, *Kinberg.*

As regards the Channel this species has only been taken on the oyster ground off St. Peter Port, Guernsey, along with Hermione (McIntosh, 20). It appears to be a northern species, and is found at considerable depths, chiefly on muddy sand.

Möbius (27) records it on mud in the North Sea.

LOCALITY.

St. Peter Port, Guernsey		McIntosh (16).

* HERMIONE HYSTRIX, *Savigny.*

Rather common. It occurs chiefly on the gravel grounds in the neighbourhood of the Eddystone at a depth of about 30 fathoms.

McIntosh (20) records it as partial to shell débris, gravel, and similar regions, while Pruvot (29) finds it on the coast of Brittany in the littoral zone. In the middle (Himanthalia) region of this zone it occurs among seaweed on a sandy bottom, and lower down it lives on a coarse sand, passing to fine sand at greater depths.

LOCALITIES.

Plymouth : Stoke Point ; Mewstone Ledge ; Rame Head, 3 miles S.W. ; 3–6 miles S.W. (R. A. T.) ; Penlee, 5 miles S.W. (R. A. T.).

Eddystone IX., X.	Coarse gravel with sand or mud.	Allen (1).
St. Peter Port, Guernsey	Shell-gravel, etc.	McIntosh (20).
Côtes du Boulonnais	Dredgings	A. Malaquin (21).
Dinard	Common enough on the shore and at extreme low tide, and in dredgings at all depths	de St.-Joseph (31).
Baie de Cancale	On oyster beds	Audouin and Milne-Edwards (2).
Iles Chausey	Among seaweeds on a muddy bottom, exposed only at the very lowest tides	Audouin and Milne-Edwards (2).
Côtes de Bretagne		Pruvot (29).

* LEPIDONOTUS SQUAMATUS, *Linn.*

This is one of the most abundant species, and occurs everywhere and in all situations from between tidemarks to deep water.

It is not infrequent on the shore under stones, and occurs in the holes and crevices of stones brought up by the dredge, as well as in the miscellaneous collection of material which includes *Chætopterus* tubes and a varied assortment of Hydroids and Polyzoa from all parts visited by the Association.

Möbius, writing with reference to the North Sea, gives as its habitat stones, sand, and shells ; sandy mud ; sand with small stones and shells ; dead zostera (27) ; red algæ ; stones, sand, and red algæ (Baltic) (26).

Pruvot (29) confines it to tidal waters at all levels, and the laminarian zone on stony ground of various kinds.

LOCALITIES.

Plymouth : Area general.

Eddystone Grounds	Fine sand ; coarse gravel with sand or mud ; fine gravel ; shell-gravel ; stones	Allen (1).
Salcombe	Coralline region	Parfitt (28).
Falmouth, South Devon, Weymouth		Johnston (16).

Côtes du Boulannais	Very abundant	A. Malaquin (21).
Wimereux, Plymouth		Darboux (8).
Dinard	Very common on shore and in dredgings	St.-Joseph (31).
Havre, Villerville, Villers, Lui-sur-Mer		St.-Joseph (32).
St. Vaast, Concarneau, Croisic	All along the coast under stones	de St.-Joseph (33).
Côtes de Bretagne		Pruvot (29).
St. Vaast		Grube (14).

* LEPIDONOTUS CLAVA, *Montagu.*

This species is very common, but by no means so abundant as the last, and is more restricted in its distribution. It occurs below tide-marks, but between them it is most numerous at extreme low water under stones. All authors seem to agree in limiting the size of this species to something like an inch and a half, but local specimens of such a size would be regarded as small. They frequently occur up to 2¼ inches, and sometimes even more. Under these circumstances the elytra are widely separated, and a very good figure of the worm in this condition is given by Bourne (4). Pruvot (29) records it from the higher strata of tidal waters among fucus-covered rocks in the Channel, and from the same zone in the Golfe du Lion in the Mediterranean.

LOCALITIES.

Plymouth : Breakwater, Cattewater, Rum Bay, Wembury Bay, the Bridge.

South Devon, Falmouth	Johnston (16).
Wimereux	Darboux (8).
Concarneau, St. Jean de Luz, Croisic	St.-Joseph (32).
Côtes de Bretagne	Pruvot (29).

† LEPIDONOTUS PLEIOLEPIS, *v. Marenzeller.*

The species described under this name is recorded from the Japanese seas, and is characterised by the possession of 15 elytra, a fact which should lead to a modification of the genus. St.-Joseph describes a specimen from Cézembre, which he assigns to this species. As it only possesses 12 elytra and is very small, he somewhat apologetically explains that it is only a young one.

LOCALITY.

Dinard (Cézembre)	Dredging 20 m.	de St.-Joseph (31).

* MALMGRENIA CASTANEA, *McIntosh.*

By no means uncommon. This species has, in this locality at least, only been found as a commensal on the under surface near the mouth of *Spatangus purpureus,* and is therefore found on the same kind of ground as that frequented by the echinoderm.

I have not been able to ascertain from the writings of various authors whether the worm exists in a free state or not, but McIntosh (20) quotes it as having been found on *Astropecten irregularis* by Prof. Harvey Gibson and Mr. Hornell in the Liverpool district.

LOCALITIES.

Plymouth : Mewstone Grounds, Whitsand Bay, Stoke Point.

St. Peter Port, Guernsey	. . . .	McIntosh (20).
St. Vaast . .	Dredgings . . .	de St.-Joseph (32).

*GATTYANA CIRROSA, *Pallas.*

This species is perhaps better known under its older name of Nychia, which has been relegated to obscurity by McIntosh.

It is a fairly common species in the vicinity of Plymouth. It is found in the dredge material from the Eddystone grounds in a manner which, if it does not occur free, does not indicate a very close relation between it and its host. At Salcombe it has recently been taken in some numbers in the tubes of *Amphitrite Johnstoni.* It is essentially a commensal, and has been found in the tubes of *Chætopterus variopedatus* (Baird, *fide* McIntosh, 20; Hornell, 15); *Thelepus cincinnatus* (Hornell, 15); *Amphitrite figulus* (Dalyell, 20). Malaquin describes a definite variety from the tubes of *Chætopterus* on the Côtes du Boulonnais. Pruvot records it only from the zostera region, where the bottom is sandy.

LOCALITIES.

Plymouth: Mewstone, Eddystone, Yealm (with *Amphitrite Johnstoni*, R. A. T.).

Salcombe . .	Commensal with *Amphitrite Johnstoni* . . .	
South Devon . .	. . . .	Johnston (16).
Herm, Channel Islands	. . . .	McIntosh (20).
Côtes du Boulonnais .	*Chætopterus* tubes . .	Malaquin (21).
Dinard . .	*Chætopterus* tube . . .	de St.-Joseph (31).
St. Malo . .	. . . .	Grube (12).
Côtes de Bretagne .	. . . .	Pruvot (29).
St. Vaast . .	. . . .	Grube (14).

*HARMOTHOË MARPHYSÆ, *McIntosh.*

This species is not yet known from the Plymouth district, though its host, *Marphysa sanguinea*, is fairly common. McIntosh records it from the Cornish coast.

LOCALITIES.

Polperro . .	Chinks in rocks . .	McIntosh (20).
Guernsey . .	Galleries of *M. sanguinea*	McIntosh (20).
Roche Bernard . .	Côtes du Boulonnais .	Malaquin (21).

†HARMOTHOË MAXILLOSPINOSA, *de St.-Joseph.*

Recorded from Dinard by de St.-Joseph, who found it several times in dredgings. Pruvot's laminarian (gravel) region.

†HARMOTHOË PICTA, *de St.-Joseph.*

First recorded from Dinard, where de St.-Joseph found a single specimen on the shore in an empty tube of *Lanice conchilega*, and subsequently it was found in greater numbers, and from other localities on the French coast, where it occurred as a tidal form.

LOCALITIES.

Dinard . . .	Tubes of *Lanice* . . .	de St.-Joseph (31).
St. Jean de Luz, Hendaye	Under stones . .	de St.-Joseph (32).

†HARMOTHOË LJUNGMANI, *Malmgren.*

Not yet recorded from the neighbourhood of Plymouth. McIntosh records it as a tidal and a deep-water form, but Pruvot only includes it in his laminarian zone.

LOCALITIES.

Dinard . . .	Dredgings . . .	de St.-Joseph (31).
Côtes de Bretagne .	Laminarian (gravel) zone .	Pruvot (29).

*HARMOTHOË LUNULATA, *Delle Chiaje.*

A not uncommon tidal form. It may be found among the laminarian roots on the Plymouth Breakwater, and occasionally hidden under stones near low water.

Hornell (15) states that this species may be found in the ambulacral grooves of *Astropecten irregularis.*

LOCALITIES.

Plymouth: Breakwater, the Bridge, Rum Bay.	
Salcombe.	
Channel Islands	McIntosh (20).

*HARMOTHOE SPINIFERA, *Ehlers.*

This is a very common species at Plymouth, and one in which the colouration, always presenting a wide range in the Polynoids, is sufficiently constant to make it readily recognisable. It is found in all parts of the Sound where rocks and stones occur, in the crevices of which it appears to dwell.

Pruvot (29) notes it from the laminarian region only, which corresponds with my experience, though McIntosh (20) gives a locality which is apparently within tidal limits.

Localities.

Plymouth: Millbay Channel, Duke Rock, Queen's Ground.		
Polperro	Chinks in rocks	McIntosh (20).
Côtes du Boulonnais		Malaquin (21).
Dinard	Common in dredgings	de St.-Joseph (31).
Côtes de Bretagne	Laminarian (gravel)	Pruvot (29).

*Harmothoë setosissima, _Savigny_.

McIntosh (20) records it both as a tidal and deep-water species, in the latter case also as an inhabitant of *Chætopterus* tubes. It is occasionally found among the Polyzoa (*Cellaria*) and *Chætopterus* tubes from the Eddystone Grounds. I have only seen a few examples.

Localities.

Plymouth: Eddystone Grounds.		
Plymouth (E. M.)		McIntosh (20).
Salcombe.		
Herm, Channel Islands		McIntosh (20).
Herm	*Chætopterus* tubes	Lankester (19).
Côtes du Boulonnais	*Chætopterus* tubes	Malaquin (21).
St. Vaast	Dredgings	de St.-Joseph (32).
Roscoff		Grube (21).
St. Vaast		Grube (14).

*Harmothoë areolata, _Grube_.

Not uncommon on the Eddystone Grounds, where the dredge or trawl brings up masses of Polyzoa, Hydroids, and *Chætopterus* tubes.

Localities.

Plymouth: Eddystone Grounds.		
Herm, Channel Islands	Tubes of *Chætopterus* (Cooper), and under stones	McIntosh (20).
Herm	Under stones and in or near tubes of *Terebella nebulosa*	E. Ray Lankester (17).
Côtes du Boulonnais	Dredgings, *Chætopterus* tubes, rarely on shore	Malaquin (21).
Dinard	Rare in dredgings; young only	de St.-Joseph (31).
Côtes de Bretagne	Fucus zone	Pruvot (29).

†Harmothoë cæliaca, _de St.-Joseph_.

Recorded only from Dinard by de St.-Joseph, who found it on several occasions in dredgings. Pruvot's laminarian (gravel) region.

†Harmothoë arenicolæ, _de St.-Joseph_.

Recorded only from Dinard by de St.-Joseph, who found it on the shore attached to a specimen of *Arenicola*.

*Harmothoë imbricata, *Linn.*

Not an abundant species, but at the same time fairly common. McIntosh regards the Channel as very near its limit of distribution, its place being taken in the south by *Lagisca floccosa.* In the neighbourhood of Plymouth it occurs between tidemarks and in deeper water. It is found among broken shells or stones covered with sponges, hydroids, polyzoa, and *Chætopterus* tubes on the Eddystone Grounds, and also under laminarian roots and suchlike crevices on the Breakwater.

McIntosh (20) gives similar localities, and adds the tubes of *Terebella* and *Chætopterus,* and also old shells with *Polycirrus.*

Pruvot (29) finds it on the coasts of Brittany, in the Fucus as well as the Cystoseira zones of tidal waters, but he does not notice it in the laminarian zone.

Möbius (26), referring to the Baltic, finds it among zostera and red algæ, also on sand, mud, and muddy sand of various qualities, to a depth of nearly 100 fathoms. Again in the North Sea (27) he adds 10 fathoms to the depth, and as habitat, stones, shells, etc., variously combined with sand, mud, or both.

Localities.

Plymouth: Breakwater, Rum Bay.		
Eddystone Grounds	III. and VII. fine sand; XVI. shell gravel,	[T.V.H.] Allen (1).
Torbay		Gosse (10).
South Devon		Johnston (16).
Channel Is., Guernsey	Rare	McIntosh (20).
Côtes du Boulonnais	Under stones and in dredgings	Malaquin (21).
Dinard		de St.-Joseph (31).
Granville, Noir-moutier, and coasts of Brittany		Audouin and M.-Edwards (2).
Côtes de Bretagne	Littoral zone	Pruvot (29).
St. Vaast		Grube (14).

†Harmothoë reticulata, *Claparède.*

de St.-Joseph doubtfully refers a mutilated specimen taken near Dinard to this species.

Pruvot (29) records it from the Fucus zone of tidal waters, the zostera banks on a sandy bottom, stones covered with Cystoseira to the sandy gravel of his laminarian zone.

McIntosh (19) considers that this species is in all probability identical with *Evarne impar.*

Localities.

Dinard (Cézembre)	Dredging	de St.-Joseph (31).
Côtes de Bretagne		Pruvot (29).

†Harmothoë torquata, *Claparède.*

This species, which closely resembles *H. spinifera* of Ehlers, is an inhabitant of the Fucus zone of tidal waters, and is recorded by Pruvot (25) from the coasts of Brittany. It is introduced here on his authority.

†Harmothoë Sarniensis, *Lankester.*

This species is recorded by Prof. Ray Lankester from Guernsey and Herm, where it appears to have been very abundant under stones near low-water mark.

According to Lankester it appears to replace *H. imbricata*, which it resembles very closely in other respects than the number of the elytra.

It is not noticed by McIntosh in his recent Monograph (20).

Localities.

Guernsey and Herm	Lankester (17).

*Eunoa nodosa, *M. Sars.*

This fine species is only occasionally found, and the only locality in the neighbourhood of Plymouth is the Eddystone Grounds.

Localities.

Eddystone Grounds	XVIII.	Stones	[Weldon]. Allen (1).

*Evarne impar, *Johnston.*

A very common tidal and deep-water species. McIntosh (20) states that it occurs under stones between tidemarks, in the crevices of tangle roots, and in the cavities of shells, both univalve and bivalve. This accords completely with my own experience in this neighbourhood, throughout which it appears to be pretty generally distributed. de St.-Joseph (32) describes the variety *Pagenstecheri* from St. Lunaire.

Pruvot (29) records it from his laminarian zone with a gravelly bottom, and also from the fine sand of the coastal region.

Localities.

Plymouth: Area general.

Eddystone Grounds	VII. fine sand. XIV. fine gravel. XVIII. stones,	Allen (1), T. V. H.
Salcombe	Coralline zone	Parfitt (28).
Salcombe		T. V. H.
Torbay, Anstey's Cove		Gosse (10).
Herm, Channel Islands	Between tidemarks	McIntosh (20).
Wimereux		Darboux (8).
Dinard (rare), Isle de Rochefort, Saint Jacut		de St.-Joseph (31).
Portel, Côtes du Boulonnais	Under stones between tidemarks	A. Malaquin (21).
Baas, Côtes du Boulonnais	Sand bank, dredgings	A. Malaquin (21).
St. Lunaire, Côtes de France		de St.-Joseph (32).
St. Malo		Grube (12).
Côtes de Bretagne	Laminarian and coastal zones	Pruvot (29).

†EVARNE PENTACTÆ, *Giard*.

Lives on the body of *Cucumaria pentactes*, with which holothurian it is commensal. It has not been recorded from this side the Channel.

LOCALITY.

Grisnez, Wimereux		Giard (9).

*LAGISCA FLOCCOSA, *Savigny*.

This is one of the commonest of the local species, and may best be described as having a general distribution throughout the local area. It occurs between tidemarks to deep water, and under the synonym of *L. propinqua* it is recorded from the sand and gravel of the Eddystone Grounds.

LOCALITIES.

Plymouth: Area general.		
Eddystone Grounds	Fine sand, coarse gravel with sand or mud, fine gravel, shell-gravel, stones	Allen (1).
South Devon		Johnston (16).
Wimereux		Darboux (8).

*LAGISCA EXTENUATA, *Grube*.

Not uncommon. It occurs most frequently under the laminarian roots on the Breakwater, and more rarely on the Eddystone Grounds, among the Polyzoa and *Chætopterus* tubes.

McIntosh (20) records it from the tube of a *Eunice*, and free on muddy sand; while Pruvot (29) gives its habitat as the Fucus zone down to the base of the rocks covered with Laminaria, and with a somewhat variable bottom.

LOCALITIES.

Plymouth: Breakwater, Eddystone Grounds.		
Roche Bernard, Roche de Lineur, Côtes du Boulonnais	Dredgings, especially at Platriers	Malaquin (21).
Wimereux		Darboux (8).
Dinard	Dredgings	de St.-Joseph (31).
St. Vaast, St. Guénolé, Croisic, St. Jean de Luz		de St.-Joseph (32).
Côtes de Bretagne	Littoral zone	Pruvot (29).

*LAGISCA RARISPINA, *Sars*.

This species is not admitted by McIntosh in his "Monograph of the British Annelids," nor is it included amongst the synonyms.

It appears to me to be very closely related to *L. floccosa*, with which species I should probably have identified it, had not Prof. Weldon drawn my attention to it in dealing with the Polychætes from the

Eddystone Grounds (1). Since then I have found it in some numbers from that area and from the adjacent Mewstone Grounds.

LOCALITIES.

Plymouth: Eddystone Grounds, Mewstone Grounds.

Eddystone Grounds (1) VII.	Fine sand	[Weldon]. Allen (1).
Wimereux		Darboux (8).
Between Ridens and Vergoyer, Pierrettes, Côtes du Boulonnais		M. Sauvage, A. Malaquin (21).

†SCALISETOSUS COMMUNIS, *Delle Chiaje.*

Not yet recorded from the neighbourhood of Plymouth.

Hornell (15) states that this species has been found commensally on three different kinds of starfishes.

LOCALITIES.

Channel Islands		McIntosh (20).
Côtes du Boulonnais	Dredgings	Malaquin (21).
Dinard	Dredgings	de St.-Joseph (31).
Lanvéoc, Brest		de St.-Joseph (33).
Côtes de Bretagne	Laminarian (gravel)	Pruvot (29).

*SCALISETOSUS ASSIMILIS, *McIntosh.*

This species has recently been found upon the oral region of *Echinus esculentus*, Mr. R. A. Todd bringing it to my notice. I think I am justified in saying that it is not uncommon.

LOCALITIES.

Plymouth: Penlee, 3–5 miles S.W. (R. A. T.), Mewstone Grounds.

Lanvéoc, Brest		de St.-Joseph (33).
Côtes de Bretagne	Laminarian (gravel)	Pruvot (29).

†SCALISETOSUS ECHINI, *Giard.*

Found by Giard as a commensal on the sea urchins *Echinus sphæra* and *E. esculentus*, in 30 fathoms.

LOCALITY.

Concarneau	Giard (9).

POLYNOE SCOLOPENDRINA, *Savigny.*

McIntosh (20) gives the habitat of this species as the tubes of *Polymnia* (*Terebella*) *nebulosa*, between tidemarks, Herm, and between the chinks of rocks (gneiss), in muddy sand in the burrows of *Lysidice*. Other authors confirm the residence of this species more or less closely with *Polymnia nebulosa*, while de St.-Joseph (31) states that it is found on the shore under stones, where it constructs a tube of sand and bits of shell.

Here at Plymouth it has only been found in two localities, viz. Millbay Channel and the Eddystone Grounds.

Specimens from the former locality make their appearance at rather long intervals, so that it cannot be called common, and it seems to frequent the chinks and crevices of the rocks which are found there, the depth being about 25 fathoms. Only a single specimen has been found on the Eddystone Grounds. This is considerably larger than the Millbay forms. It measures some 3½ inches in length, and the dorsum in the hinder part of the body bears three longitudinal rows of well-developed tubercles.

The Millbay specimens are small, barely two inches in length, and give one the idea of being disproportionately narrower. The dorsum is not tuberculated. In colour the specimens are approximately alike.

LOCALITIES.

Plymouth : Millbay Channel.

Eddystone Grounds		Allen (1).
Falmouth		Johnston (16).
Channel Islands		McIntosh (20).
Dinard	Dredgings and on shore	de St.-Joseph (31).
St. Malo	With terebellids	Audouin et M.-Edwards (2).
St. Malo, Roscoff		Grube (12).
Côtes de Bretagne	Himanthalia and laminarian zones	Pruvot (29).

* HALOSYDNA GELATINOSA, *M. Sars.*

Not infrequently found on the shore under stones which rest on a basis, sometimes very scanty, of sandy mud, and occasionally in deep water. It cannot be called an abundant species. McIntosh (20) gives it its habitat under stones and in crevices, laminarian roots between tidemarks, and in the valves of old shells in deeper water.

Pruvot (29) gives the habitat of this worm on the coast of Brittany as the middle (Himanthalia) zone of tidal waters, and also his laminarian zone among the Laminaria, which accords with its distribution in the neighbourhood of Plymouth.

LOCALITIES.

Plymouth: Rocks below Laboratory, Rum Bay, Mewstone Grounds, off Stoke Point (R. A. T.), Wembury Bay (R. A. T.), Drake's Island (R. A. T.).

Eddystone Grounds IX.	Coarse gravel, with sand or mud	Allen (1).
Channel Islands		McIntosh (20), Lankester (17).
Dinard	At lowest tides in the holes bored in the mud by *Nerine*.	de St.-Joseph (31).
Roscoff		Grube (12).
Côtes de Bretagne	Himanthalia and laminarian zones	Pruvot (29).

* ACHOLOË ASTERICOLA, *Delle Chiaje*.

Commensal in the ambulacral groove of *Astropecten irregularis*, this species is decidedly common, a very fair percentage of these echinoderms being accompanied by the worm. It is comparatively easy to find them; their colour betrays them, and they can be readily turned out of the ambulacral groove of the starfish, though it has hitherto proved impossible to preserve specimens entire.

Within an hour or two of capture the worm will voluntarily leave its host, and may be found wandering over the various animals with which it may be temporarily associated. This leads one to suppose that it is free during some portion of its existence, though I can find no evidence of its having been obtained in such a condition.

It occurs on several species of the genus *Astropecten*, Carus (5).

LOCALITIES.

Plymouth: Mewstone Grounds, off Stoke Point, S.W.; Penlee Point, 5 miles S.E.; Rame Head, 5 miles S.E. (R. A. T.).

Eddystone Grounds I., II., III. . . Fine sand . . . [T. V. H.] Allen (1).

LEPIDASTHENIA ARGUS, *sp. nov.* Size to 8½ inches.

GENERAL APPEARANCE. An elongated worm of upwards of 200 segments, coloured a warm buff, with a transverse band of dark brown between each segment. A red longitudinal line on ventral surface.

Elytra numerous, not very large comparatively, completely covering the sides of the body, but leaving a conspicuous median portion exposed; translucent, with a dark-coloured, more or less fan-shaped patch posterior to the centre; behind this a narrow crescentic band of opaque white.

SPECIFIC CHARACTERS.

PROSTOMIUM. Broad, red, with an antero-median depression dividing it into two lobes. Tentacles three, sub-equal, produced from the anterior margin of the prostomium. Median tentacle long, comparatively stout, distinctly swollen near the filiform tip, lateral tentacles more slender, the swelling indistinct. Tentacular cirri similar to the lateral tentacles. All these organs are smooth and possess a deeply pigmented band at the distal portion of the swelling, which is marked by a band of opaque white.

Eyes four, anterior pair wider apart and slightly larger than the posterior. Proboscis with $\frac{11}{11}$ papillæ and a small additional one on each side, a short distance from the extremity.

ELYTRA. On segments 1, 3, 4, 6, 8, . . . 22, 25, 28, *et seq.*, to the end of the body. The first is subcircular, some few are uniform, but most are an irregular circle. Surface and margin quite smooth. Translucent, with faint granular pigment. Immediately behind the point of attachment is a brown-coloured patch with a sharp anterior border, fading gradually inwards and backwards. In the posterior elytra this pigmented area occupies most of the hinder portion of the elytron, and is fan-shaped. Near the posterior margin is a more or less conspicuous crescentic band of opaque white.

PARAPODIA. Notopodium reduced to a mere stump with a very few slender chætæ or none. Dorsal cirrus resembling tentacular cirri, and extending nearly to the extremity of the chætæ, except in a few of the anterior segments where it projects far beyond. Neuropodium well developed with numerous chætæ of a tolerably uniform character; the upper ones are longer and more slender. The spinulose rows are well developed; there are about forty of these on the more slender chætæ, and they become reduced to about twelve on the ventral side, the chætæ becoming shorter and stouter and finally more curved. The chætæ are bifid.

This remarkably fine species has recently been discovered at Salcombe by Mr. Todd, existing as a commensal in the tubes of *Amphitrite Edwardsi.*

It is one of the most brilliantly coloured of the Polynoids, and I am indebted to Mr. W. Garstang for the following description of the colour when alive:—

"General colour a warm buff, occasionally inclining to pink in some specimens. The intervals between the segments are marked by a conspicuous transverse bar of dark brown. In the anterior half of the body the bases of the cirrus-bearing parapodia are also coloured dorsally with a diffuse patch of the same pigment, which is scarcely perceptible on the elytron-bearing segments.

"In the posterior half of the body the pigment on the bases of the cirriferous parapodia fades completely away.

"Each elytron bears a dark brown patch immediately behind its point of attachment and spreading inwards towards the posterior border. The anterior margin of this pigmented area is sharp and well defined, but fades away distally. These pigmented areas lie on the lower surface of the elytra, but are clearly visible through their translucent integuments. In the anterior segments the spots are smaller and more strongly pronounced than in the posterior segments, where they gradually assume a broader and more fan-shaped outline. A more or less crescentic streak of opaque white near the posterior border of the elytra adds to the conspicuous character of these markings."

While this description was being prepared I was enabled to visit Salcombe during the spring tides of October, when I secured a dozen specimens of the species. The colour varies a good deal while retaining all its essential characteristics, and in some individuals the dark brown appears to be more of a purple. I am inclined to believe that the natural colour is a purple rendered a rich brown by virtue of its intensity. Some of the individuals taken showed this very clearly, and in one case one half of the body was conspicuously lighter than the other.

The ventral surface is practically colourless except for a very strongly marked longitudinal line of bright red.

ELYTRA. In shape they are sub-circular, and some few reniform. From a certain variation in size it may be assumed that they are lost and replaced with comparative ease, though this is hardly borne out by the circumstances connected with their capture and preservation. The surface and margin are both smooth. Under the microscope a light brown pigment is visible over the entire surface of the elytron, and differs only in density from the visibly pigmented area. This pigment is deposited in small circular patches, each having a lighter spot in the centre. From the area of attachment the nerve runs in an arborescent manner over the entire elytron, the branching being very close and delicate.

PROSTOMIUM. Broad; the posterior portion is pigmented brown (in spirit). It consists of two ovoid lobes separated anteriorly by a median depression, which loses itself about half-way back. The tentacles are continuations forward of the prostomium, and their proportionate lengths seem to vary somewhat. The four eyes are postero-lateral in position, but not in contact with the margin; the anterior are slightly larger than the posterior.

PARAPODIA. Elongate, with the notopodium rudimentary.

First foot. The notopodium consists of a mere papilla, with a slender and tapering chæta. The neuropodium is well developed and subconical. It is provided with some thirty or more slender chætæ. The spinulose region of these is bent backwards and long. The apex is apparently truncate, but there are evidences of a minute cleft. The more ventral chætæ are shorter; the spinulose border is turned ventralwards. The ventral cirrus is very long.

The second foot is very similar; the ventral cirrus reaches beyond the neuropodium, and the dorsal cirrus extends very considerably further. The chætæ do not present any striking differences.

In the typical feet the notopodium increases in size for the stout part of the animal's body, and may carry four or five long, slender chætæ with no serrulations. In the neuropodium three groups of chætæ may be made out: an upper group, where the chætæ are few in number, long and slender, and with the spinulose region proportionally long; a median group, where the chætæ are by far the most numerous, and are stout, the spinulose region being distinctly shorter, and shortening as the chætæ pass to the ventral region, where it is shortest. The shafts of the most ventral chætæ are distinctly more slender, and form the third group, which is not always so sharply defined as the others.

The ventral cirrus is scarcely half the length of the neuropodium measured from the point of insertion of the cirrus.

With the doubtful exception of the first two feet, all the chætæ are bifid at the extremity, the only difference being the depth of the cleft.

The presence of chætæ in the notopodium is not a constant character. No definite statement can be made either as to the number of the segments or of the elytra, as these appear to be directly related to the size of the animal. The largest specimen I have seen measures 8½ inches in length with 67 elytra and 190 segments, and the smallest is 1½ inches long with 22 elytra. This last specimen, having been a month or so in spirit, is almost colourless. Another specimen, 2 inches long with 30 elytra, possesses the characteristic colour, but very feebly developed. In these two cases the elytra completely cover the body. A specimen, 5⅝ inches long with 54 elytra and 150 segments, has assumed the character and proportions described for the species. Specimens of intermediate size are necessary to trace the change in the proportions and colouration of the elytra.

The segmental papillæ are very prominent, more especially in the posterior part of the body, and the anus is provided with two short cirri.

The generic definition of Lepidasthenia given in the synopsis (p. 232) is a verbatim copy of Malmgren's original. This author appears to have had one or more specimens. Neither here nor in the original description of Grube's *Polynoe elegans* are any figures given, and nothing is said as to its habits. A figure, however, is given by Benham (**3**) in the *Cambridge Natural History*, and this unquestionably proves that the Salcombe species is distinct. This species does not accord with Malmgren's definition in the matter of the parapodia, but the difference does not justify the creation of a new genus, and the existing one must be amended in that particular.

*STHENELAIS BOA, *Johnston.*

This is a common species, and occurs between tidemarks on a more or less sandy bottom, burrowing in the sand or under stones. It is also tolerably frequent in dredgings, especially where the bottom consists of stones and broken shells.

Pruvot (**29**) records it from sandy beaches near low tide, and from the zone of zostera banks.

Möbius (27), referring to the North Sea, reports it generally on sandy ground, of varied character, frequently also with shells and shell fragments, sometimes on mud or on sand more or less mixed with mud.

Localities.

Plymouth: Drake's Island, Rum Bay, Bovisand Bay, off Rame Head, Mewstone Ground.		
Salcombe	Zostera banks, and near low tide.	
Exmouth	Tidemarks	Parfitt (28).
South Devon		Johnston (16).
Channel Islands, Herm		McIntosh (20).
Wimereux, Plymouth		Darboux (8).
Dinard	In muddy sand all along the coast	de St.-Joseph (31).
St. Malo, Roscoff		Grube (12).
Côtes de Bretagne		Pruvot (29).
St. Vaast		Grube (14).

*STHENELAIS LIMICOLA, *Ehlers*.

The record of McIntosh cited below is all that I know of this species occurring in the neighbourhood of Plymouth. He notes it as an inhabitant of sandy ground in water of some depth, never between tidemarks.

Localities.

Cornwall, Polperro	McIntosh (20).

†STHENELAIS MINOR, *Pruvot and Racovitza*.

Taken once in a dredging between Ile Ronde and Lanvéoc Point, near Brest by de St.-Joseph. He expresses some doubt as to the identity of the species.

Pruvot (29) records it from the gravel at the base of his littoral zone.

Localities.

Lanvéoc	Dredging	de St.-Joseph (33).
Côtes de Bretagne	Littoral	Pruvot (29).

†SIGALION MATHILDÆ, *Aud. et Edw.*

Recorded by McIntosh as a tidal form occurring under stones, and extending to deeper water on a more or less sandy ground. Pruvot (29) says sandy beach near low tide. Möbius (27) reports it from the North Sea on fine sand with shells.

Localities.

Channel Islands		McIntosh (20).
Boulogne-sur-Mer		Darboux (8).
Isles Chausey		Audouin et M.-Edwards (2).
Dinard	On sand on the shore	de St.-Joseph (31).
Poulingen, St. Vaast, Villers	On sand	de St.-Joseph (32).
Côtes de Bretagne	Littoral	Pruvot (29).

†Psammolyce Herminiæ, *Aud. et Edw.*

Pruvot (29) includes this species in his list of Polychætes from the coast of Brittany. He records it from the sandy beaches near low tide, and from the fine sand of the coastal region.

Localities.

Côtes de Bretagne		Pruvot (29).

†Pholoë minuta, *Fabricius.*

This is a tidal as well as a deeper water species, and is found commonly under stones between tidemarks, and especially in pools (20). I have not seen it in the Plymouth neighbourhood.

Localities.

Channel Islands		McIntosh (20).
Wimereux		Darboux (8).
St. Malo		Grube (12).
St. Vaast		Grube (14).

†Pholoë synophthalmica, *Claparède.*

A variety of this species, to which de St.-Joseph gives the qualification *var.* Dinardensis, is recorded as common in dredgings at all depths off Dinard.

Pruvot (29) records it from the base of his littoral zone with a gravelly bottom, to the fine sand of the coastal region.

Localities.

Dinard		de St.-Joseph (31).
Côtes de Bretagne	Littoral and coastal	Pruvot (29).

I have not sufficient information to assign to the following species their correct position.

Polynoe lævis, *Aud. et Edw.*

This species, according to Pruvot (29), is found on the sandy zostera banks of tidal waters, but may also be found in deeper water.

Audouin and Milne-Edwards, who first described this species, give no information as to the conditions under which it was found. The description has not that precision which is demanded by modern specialisation.

Localities.

Isles Chausey		Audouin and Edwards (2).
Litora Francogalliæ		Carus (5).
Côtes de Bretagne	Zostera beds	Pruvot (29).

LÆNILLA ALBA, *Malmgren.*

Recorded by Grube from the French coast, but details of its capture are not given. The genus Lænilla of Malmgren has been modified and broken up, and this species would probably be included in the genus Malmgrenia of McIntosh.

LOCALITY.

St. Malo, Roscoff	Grube (12).

SCALISETOSUS VARIEGATUM, *Gr. et Kr.*

Included here on the authority of Pruvot (29), who includes it in his list of species occurring on the coast of Brittany. I have not met with any other allusion to the species.

LOCALITY.

Côtes de Bretagne .	*Cystoseira* region . . .	Pruvot (29).

NOTE ON PRUVOT'S BIOLOGICAL REGIONS.

Pruvot (29) has dealt at some length with the fauna of the coast of Brittany and that of the Golfe du Lion in the Mediterranean.

In comparing the faunas of these two regions he shows how the life of the various species is intimately related to the conditions to which they are exposed, and the character of the surface on which they live.

I have here incorporated a summary of his observations in so far as they apply to the group under consideration and as regards the Channel fauna only.

It will be seen that his observations very accurately describe the distribution of Polychætes in the neighbourhood of Plymouth, but reference must be made to his work for one to realise its importance.

As his terminology differs from that in general use in this country it needs some explanation. He divides the depths of the sea into three regions: (1) Littoral, (2) Coastal, and (3) Abyssal, the last of which is not, of course, found in the Channel.

The littoral region is that in which the bottom is subjected to the influence of waves and superficial currents, and extends so far as to include the laminarian and a considerable portion of Forbes' coralline zone. The coastal region occupies the whole of the Channel below a depth of about 21 fathoms.

The following table will show better than mere description the subdivision and character of these regions and the three "facies" ascribed to each zone:—

		ROCKY.	SANDY.	ESTUARINE.
	Subterrestrial zone .	Rocks covered with *Balanus*. Rocks covered with *Pelvetia*.	Pure sand with *Talitrus*.	Mud-banks, ordinarily exposed.
1. LITTORAL REGION.	Upper . .	Rocks covered with *Fucus*.	Upper beach with *Cardium edule*.	River mud. Fucus. Sandy mud with *Arenicola*. Muddy gravel of ports.
	Littoral zone, Middle . .	Stones with *Cystoseira*. Rocks with *Himanthalia*. Large overhanging rocks and caves	Banks of zostera. Lower beach with *Solen* & *Dentalium*.	Muddy seaweed banks. Estuarine sandy mud.
	Lower . .	Rocks with *Laminaria*.	Stones with Polyzoa, etc.	Marl.
2. COASTAL REGION.	Zone of coastal mud . .	Missing in the Channel.		
	Zone of sand .	Sand, gravel, and stones at the bottom of the Channel.		

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The Plague of Octopus on the South Coast, and its effect on the Crab and Lobster Fisheries.

By

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UNTIL the spring of 1899 the true or common octopus (*Octopus vulgaris*, L.) had been comparatively rare in the neighbourhood of Plymouth during the past ten or twelve years—*i.e.* since the opening of the Plymouth Laboratory in 1888. Specimens could only be obtained for the aquarium at long intervals, in spite of the tempting inducements offered to fishermen. As much as ten shillings has more than once been given to fishermen for a specimen of this voracious mollusk. On the other hand, the smaller and less powerful octopod known as *Eledone cirrosa* was almost always obtainable, and the octopus tank in the aquarium was rarely devoid of several specimens.

In the early part of last year (1899) the situation began to change, and we were for the first time able to keep the tank supplied with a number of true octopus, since which date there has been no difficulty in procuring an unlimited number of specimens, either from the professional fishermen or in the ordinary course of our own fishing operations.

We noticed this increase in the abundance of octopus before there was any means of judging whether it was a purely local phenomenon, or was observable over a wider area. The first specimens were brought to us in January, and from May onwards they were obtained in increasing abundance. Early in the same year, however (though I have no exact record of the date), a visitor from the Channel Islands informed me that the increase of octopus in those islands was so great as to have already caused much damage to the shell fisheries there, since the octopus entered the pots of the fishermen, and destroyed the crabs and lobsters which had been caught.

Later in the year paragraphs began to appear in the newspapers upon the subject, and during the present year (1900) have revealed that the increase in octopus on both shores of the English Channel has not only been of a phenomenal character, but has caused widespread disaster to the shell fisheries on the French and English coasts alike. Three of these paragraphs are sufficiently detailed to deserve quotation.

1. From the *Western Evening Herald*, Plymouth, December 18th, 1899.

"A DEVIL-FISH PLAGUE.

"A correspondent writes as follows from Rivage de Questichou, a small watering-place on the coast of the Cherbourg promontory: 'For the last two or three months this coast has been visited by a perfect octopus plague. They have quite ruined the fisheries, and many men have laid up their boats in despair. They devour everything, even crabs, and lobsters, and oysters, and all shell fish. The other day a man employed at the large oyster-beds near here told me he had that day found one that had eaten eighteen oysters that tide. The shore is strewn with octopus, and the other morning along high-water mark I counted sixty-eight in a distance of two hundred yards. A friend here measured one, and it was 5 feet 7 inches across the tentacles, but there are far larger ones than that. Some of the suckers are as large as a two-shilling piece. They are most loathsome beasts. Unless the cold winter destroys them, there will be no bathing next summer along this coast.'"

2. From the *Western Morning News*, Plymouth, September 18th, 1900.

"Budleigh Salterton crab and lobster fishery has been a very poor one this season. The failure is attributed by the fishermen in a great measure to octopi. The men say that eight or ten years since it was quite an event to take one of these creatures in their crab or lobster pots, but of late, more especially in the past two summers, their number has increased at an alarming rate, and they are now constantly being taken. The presence of the octopi is believed to be due to the excessive heat of recent summers. Not long since an octopus measuring at least 6 feet, with its tentacles fully extended, was captured off the coast, and they have often been seen close in shore, showing a preference for a pebbly or rocky bottom, and seldom seen where there is much sand."

3. From the *Fishing Gazette*, London, October 27th, 1900.

"Last year and this year the coasts of Brittany have been infested by the cuttlefish (*Octopus vulgaris*), which had been deserted by them for fifteen years previously. In the Department of Finistère they are so abundant that it is almost impossible to turn over a stone on the beach without finding one or more of the pests. In some places they have been thrown up by the sea after a storm in such quantities that their dead bodies threatened to be a danger to the inhabitants, and hundreds of cartloads had to be carted away and sold as manure.

"In the lobster and crab fishing districts of the coast they have proved so destructive of these fish that the fishermen have been obliged to look to other means of making their living."

In the Fourteenth Annual Report (for 1899) of the Inspectors of Sea Fisheries (England and Wales), an exceptional abundance of octopus is recorded by the collectors of fishery statistics for Babbacombe, Torquay, Brixham, Yealm, Mevagissey, Cadgwith, and Mousehole, all of which are fishing ports on the south-east coast of Devon and Cornwall. The collector of statistics at Plymouth reports a lack of evidence as to any exceptional prevalence of octopoda off this port, but the information obtained by ourselves leaves no doubt upon the matter.

I have attempted below to throw light upon the three practical aspects of this plague of octopus: (1) its cause, (2) its effects on the shell fisheries, and (3) the possibility of arresting its continuance by remedial measures.

I. Cause of the Plague.

There can be no doubt from its widespread character that the plague is due in the first place to an exceptional multiplication of octopus in recent years. There is some evidence, as will be shown below, that the octopus move about in marauding bands; but this is probably a local phenomenon, that cannot account for the exceptional abundance of these creatures on both shores of the Channel.

The suggestion made in the paragraph from the *Western Morning News*, above cited, is, in my opinion, nearer the truth, viz. that the cause of their prevalence is connected with the heat of recent summers.

We unfortunately know nothing directly concerning the rate of growth of this large octopod. Many small mollusks attain their full size and maturity in their second year, as I have myself shown,* but there is abundant evidence that the larger mollusks require a number of years to attain the same condition. This is well seen in those shell-bearing mollusks which form fringes † (*varices*) on their whorls. The rate of growth in littoral, as well as most land animals, is not even, but is subject to alternating periods of active growth and quiescence, in accordance with the seasons. Consequently the larger fringes on the spiral shells of many mollusks, as well as the "shoots" of an oyster's shell, afford satisfactory indication of the age of these creatures. An oyster ‡ continues to enlarge his shell by annual "shoots" for four or five years, and then ceases to grow except in thickness. The number of spiny varices on the shells of the various species of *Murex* is never less than three, and may mount up to seven or eight in certain species (*e.g. M. radix*, Fischer's *Conchyliologie*, p. 641, fig. 399). The value, from this point of view, which should be given to the ridges on the shells of ammonites (extinct cuttlefishes) is doubtful. Woodward (*loc. cit.*) suggests that they may indicate the age of the shell in years (20 to 100); but there is no more ground for this conclusion than there would be for the opinion that the septa in the shell of a *Nautilus* or a *Spirula* were of annual formation. Both structures are intimately connected with the growth and support of the body, but their formation cannot be dependent on any annual periodicity of growth, since *Spirula* at any rate lives in the abysses of the ocean (350 to 950 fms.) far below the influence of seasonal changes. On the other hand it is not impossible that the larger and thicker varices which occur at intervals along the shells of certain ammonites may indicate the extent of one year's growth (Fischer and Woodward, *loc. cit.*, pl. iii., figs. 9 and 12). On this basis the age of the specimens figured could be estimated at five or six years.

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* *Jour. M.B.A.* i., 1890, pp. 447–50.

† Woodward's *Manual of Mollusca*, 1880, pp. 12, 13, 213.

‡ Oysters may produce spat when two years old, but are most prolific in their fourth and fifth years (*fide* Hoek. See this *Journal*, N.S. i. p. 277).

From the facts recorded above concerning the rate of growth of oysters and the larger gastropods, it seems clear that the larger mollusks require at least three or four years to attain their full normal size. The octopus which have infested our coasts this year have been of various dimensions, but great numbers of them have been of phenomenal size, the arms in many cases attaining a length of 3 feet, and in some a length of 3½ feet from the mouth to the tip of the arm.

As specimens exceeding these in size are of very rare occurrence, we may assume provisionally that the age of the oldest specimens is *at least* three or four years, and, upon Woodward's theory of cephalopod growth, may far exceed that limit. The case of *Spirula* seems to me to be alone sufficient to discredit the accuracy of Woodward's theory; and a maximum age of seven or eight years for the largest specimens of octopus caught this year is the utmost that I should be prepared to assign from the analogy of other mollusks.

These estimates are probably sufficiently accurate to support the view that the plague of octopus may be traced to the influence on the reproduction of this species of the exceptionally favourable conditions which prevailed in 1893. If reference be made to the third volume of this Journal (pp. 210, 211) it will be seen that the conditions which prevailed in that year on our southern shores, as well as on the coasts of France, were extraordinarily favourable* for the reproduction of marine animals, and resulted in a great increase of the smaller mollusks, hydroids, and other forms on the south coast, as well as in an usually heavy fall of oyster spat.

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* The spring quarter was the warmest recorded in our islands for at least thirty-three years, and was succeeded by a hot, calm summer (see this Journal, vi. p. 68, Table G).

The same conditions must have also affected the octopus, and the abundance of full-grown specimens which was first noticed off our coasts in January, 1899, appears to me to be attributable to that original cause. The warm summers and mild winters which we have experienced during the past few years have also provided the conditions most suitable to a warm-water animal, and have favoured its residence in our inshore waters. In Mr. Allen's paper on the fauna of Salcombe it will be seen that we found the grotto-like nests of the octopus, together with their inmates, in considerable numbers on the shore of Salcombe estuary this year, and others have come across these unpleasant intruders when bathing inshore in Whitsand Bay and elsewhere. I myself found a minute octopus, scarcely larger than a grain of rice (3·5 mm.), when fishing with a muslin net in Salcombe Harbour in August. This shows that the creature is already established, and reproducing its kind, in our inshore waters, and augurs ill for the shell fisheries during the next few years unless, as we may reasonably expect, a severe winter during the coming season may drive the octopus off shore to deeper water,* or, again, unless remedial measures can be devised for exterminating the animal.

II. Effects on the Shell Fisheries.

The extent of the injury caused by the hordes of octopus now infesting our shores may be gathered from the subjoined table. It represents the actual catch of an experienced Plymouth fisherman (Mr. Wm. Roach) during a single week of October, and shows the total number of baited pots put down daily on the grounds, and the catch of crabs, lobsters and octopus. The number of crabs and lobsters killed in the pots by intruding octopus is distinguished from the number of uninjured shell fish. It should be borne in mind that until the last two years the entrance of an octopus into a fisherman's pots was a most exceptional occurrence, and did not happen, as I am credibly informed, more than once or twice a year. Several years might pass before the individual crab fisherman would take a single specimen in his pots.

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* Postscript, Nov. 15th. The trawling smacks are now catching large numbers of octopus both off Plymouth (5 miles from shore) and in Start Bay (20 miles S.S.E. of Berry Head). As many as 100 have been taken in one haul in the latter locality.

TABLE I., *showing the Actual Catch of Crabs, Lobsters, and Octopus by a Plymouth fisherman, in Plymouth Sound, during one week in October, 1900, distinguishing the living shell fish from those which had been killed (and often eaten) by Octopus.*

	DATE.	NO. OF POTS.	CRABS.		LOBSTERS.		OCTOPUS.
			Live.	Dead.	Live.	Dead.	
Duke Rock	Monday, 15th	10	—	6	2	4	6
Inside Breakwater . . .	,, ,,	10	—	—	1	3	4
Queen's Ground Buoy . .	,, ,,	10	1	3	1	2	5
Bovisand	,, ,,	10	—	—	—	—	1
East End of Breakwater .	Tuesday, 16th	10	2	3	1	4	4
Drake's Island . . .	,, ,,	10	—	—	1	2	3
Picklecombe Fort . . .	Wednesday, 17th	10	—	—	—	2	6
Queen's Ground Buoy . .	,, ,,	10	—	7	1	2	3
Inside Breakwater Fort . .	,, ,,	10	—	4	2	2	4
White Patch (Ram's Cliff) .	Thursday, 18th	10	—	5	1	5	7
Duke Rock	,, ,,	10	—	—	1	2	4
Batten Bay	,, ,,	10	—	—	1	1	2
Mallard	Friday, 19th	10	—	—	2	3	3
Promenade Pier . . .	,, ,,	10	—	12	1	2	2
Opposite Mt. Edgcumbe House	,, ,,	10	—	4	—	4	2
South of Drake's Island .	Saturday, 20th	10	—	—	—	1	2
Queen's Ground Buoy . .	,, ,,	10	—	—	—	2	4
Bovisand Bay . . .	,, ,,	10	—	—	—	—	2
Total	6 days	180	3	44	15	41	64
Average per diem . .		30	0·5	7·3	2·5	7	10·7

It will be seen that in Plymouth Sound, inside the Breakwater, the fisherman set thirty baited crab pots daily on an average during this experiment. His average daily catch consisted of less than one live crab and three live lobsters, and of nearly eleven octopus; while he removed daily the corpses or mutilated remains of as many as seven crabs and seven lobsters. Of eight crabs caught daily in his pots, at least seven, on an average, fell victims to the attacks of octopus; and of every ten lobsters caught only three escaped. The number of octopus caught in the pots is not an accurate measure of their actual abundance, because, unlike the crabs and lobsters, they can make their escape from the pots after entering them. In the Bovisand pots the bait was found to have disappeared, although no crabs or lobsters were caught. The capture of one or two octopus, however, in each string of pots shows that the creatures had entered the pots to devour the bait, and then taken their departure. It is, on the other hand, not improbable that the octopus actually caught in one or other of these pots were the same which had eaten the bait in the empty pots.

Be this as it may, the figures in the preceding table reveal in a striking manner the enormity of the damage which has been inflicted on the shell fisheries of the Devon and Cornish coasts during the past summer. Although they mark probably the climax of the plague so far as Plymouth is concerned, yet destruction on a similar scale took place for at least six weeks or two months previously, and on a scale not much less serious during the earlier months of the year.

One of the most remarkable phenomena connected with the plague of octopus at Plymouth took place early in September, and appears to indicate that the octopus were moving about in large marauding bands. On Sunday, September 8th, it became known that crabs of unusual size were to be found between tidemarks at Batten and other parts of the eastern side of the harbour, and more than a hundred crabs, 5 to 7 inches in breadth, were picked up in that locality in the single day, as well as larger numbers of the smaller size which normally frequent the tidal zone.*

During the next few days crabs of 4–6 inches breadth were also exceptionally abundant on the shore below the Hoe, near the bathing-place at Tinside, and were gathered by boys who took them away by dozens at a time.

On the western shore, under Mount Edgcumbe, near the "Bridge," we found no specimens exceeding 4 inches in breadth.

The explanation of the appearance between tidemarks of such exceptional numbers of fair-sized crabs is probably that the hordes of octopus had driven the crabs inshore to the shallowest margins as the only avenue of escape. The suddenness of the phenomenon, and its limitation to the eastern and northern sides of the harbour, was possibly due to an incursion into the Sound, through the eastern channel, of roving bands of octopus in search of food, though it is not improbable that the shallower declivity of the bottom and the greater extent of the tidal zone in this region may have facilitated the escape of a larger number of crabs in this part than elsewhere in the Sound.

In order to measure the general damage done to the shell-fish industry on the South Coast during the year, I have had recourse to the Board of Trade's monthly statistics of fish landed. As the practical problems presented are of an immediate character, I have thought it better not to wait until the whole year's returns have been completed, but to base comparisons on the statistics for the six summer months alone during the present and preceding years.

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* Mr. W. Demelwick, water bailiff, informs me that from the above-mentioned date to the end of October at least 600 crabs and lobsters were picked up in this locality, viz. about 200 male crabs, 4–7 inches broad; 300 female crabs, 3½–6½ inches broad; and 100 lobsters, 9–11 inches in length. He adds, "The occurrence was most unusual, and no one remembers such a thing before."

In the first place, however, it is desirable to review the annual statistics of crabs and lobsters landed on the English coasts since the commencement of the Board's returns, in order to follow the general course of the English shell fisheries during recent years.

The following table shows the numbers of crabs and lobsters returned as landed on the South Coast and on All Coasts of England and Wales annually since 1886:—

TABLE II., *showing the Number of Crabs and Lobsters annually landed (1) on the South Coast, and (2) on All Coasts of England and Wales, from 1886 to 1899, together with the Percentage Ratio in each year of the former to the latter (compiled from the Board of Trade's Returns).*

YEAR.	CRABS (thousands).			LOBSTERS (thousands).		
	S. Coast.	All Coasts.	Per cent.	S. Coast.	All Coasts.	Per cent.
1886	528	2,863	18	325	452	72
1887	630	4,081	15	399	518	77
1888	635	4,750	13	338	469	72
1889	676	5,082	13	468	720	65
1890	744	4,808	15	596	922	65
1891	632	4,612	14	531	730	73
1892	766	4,521	17	624	858	73
1893	813	5,008	16	509	747	68
1894	828	4,339	19	467	728	64
1895	893	4,501	20	442	677	65
1896	1,028	5,030	20·4	499	932	53·5
1897	911	4,018	22·5	442	700	63·1
1898	1,078	5,628	19·2	486	826	58·9
1899	1,044	4,918	21·2	449	790	56·8

Summary of the preceding Table in Averages for Successive Periods of Four Years.

YEAR.	CRABS (thousands).			LOBSTERS (thousands).		
	S. Coast.	All Coasts.	Per cent.	S. Coast.	All Coasts.	Per cent.
1886–87	579	3,472	16	362	485	75
1888–91	672	4,813	14	483	710	68
1892–95	825	4,592	18	510	752	68
1896–99	1,015	4,906	21	469	812	58

It will be seen, from the summary provided, that on the South Coast the number of crabs annually landed has increased very steadily during the entire period covered by the returns, while the quantities landed on all coasts generally have remained fairly stationary since 1887. Consequently the percentage of crabs landed on the South Coast has increased during the same period, viz. from 14 per cent. in the quadrennial period 1888–91 to 21 per cent. in the period 1896–9.

On the other hand, the quantity of lobsters annually landed on the South Coast shows no such steady increase, the maximum having been attained in the years 1890–2, while the total quantity landed on all coasts shows a progressive aggrandisement. Consequently the percentage of lobsters landed on the South Coast has declined from 75 per cent. in 1886–7 to 58 per cent. in 1896–9.

Unfortunately we have no satisfactory information as to the changes in catching power devoted to this branch of the fishing industry during the period covered by the returns of fish landed. The information contained in column 5 of the collectors' returns in the Annual Reports of the Inspectors of Sea Fisheries (E. and W.) gives a rough indication of the number of boats engaged in crab and lobster fishing since 1892, and I have tabulated the data there given for the two years 1892 and 1899 for the South Coast ports, with the following results:—

	TOTAL NO. OF BOATS ENGAGED. Class.		
	1st.	2nd.	3rd.
1892*	14	206	299
1899†	10	209	349

These figures, if reliable, indicate that there has been no appreciable increase in the number of 1st and 2nd class boats specially engaged in crab and lobster fishing‡ on the South Coast during the past eight years. The increase in the number of 3rd class (rowing) boats is probably more apparent than real, as shown by the extraordinary numbers assigned in the returns for Folkestone in 1899, and for Plymouth both in 1892 and 1899.

Consequently the increase in the returns of crabs landed during the past fourteen years may be taken as indicating an actual increase in their abundance, though this conclusion does not accord with the opinion of Plymouth fishermen whom I have questioned on the point.

The next table (Table III.) shows the average number of crabs and lobsters landed on the South Coast in each month of the year. It is compiled from the monthly returns of the Board of Trade for the entire term of fourteen years, 1886–99. It shows that the catch of shell fish varies regularly with the seasons, being low in the cold months, and high in the warm months. The six most productive months for both crabs and lobsters are seen to be those from April to September.

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* Certain obvious errors in the official published figures have been corrected as follows:—
Kingsdown.—3rd class boats assigned, 3.
Plymouth.—For "150 3rd class boats" read "25 2nd class boats."
Helford.—For "3rd class" read "2nd class."

† Corrected as follows:—
Folkestone.—Six 1st class boats and 42 2nd class boats have been eliminated, these being trawlers and line vessels.
Plymouth.—For "100 3rd class boats" read "20 2nd class boats."

‡ The number of South Coast trawling smacks (which catch a certain quantity of crabs) has not increased 5 per cent. since 1889 (see this Journal, vi. p. 67, Table E), whereas the increase in the annual returns of crabs exceeds 50 per cent. during the same period.

TABLE III., *showing the Average Number of Crabs and Lobsters landed on the South Coast of England in each month of the year (compiled from the Board of Trade's Returns for the fourteen years 1886–99); together with the Percentage of each monthly average to the average annual catch for the same series of years.*

	Crabs.		Lobsters.	
	Monthly Average (in thousands).	Per cent.	Monthly Average (in thousands).	Per cent.
January	9·6	1·2	6·4	1·4
February	17·6	2·2	16·1	3·4
March	29·4	3·7	25·8	5·5
April	49·7	6·2	33·5	7·1
May	85·3	10·7	45·2	9·6
June	147·3	18·4	74·4	15·8
July	166·6	20·8	98·5	21·0
August	129.8	16·2	78·2	16·7
September	80·7	10·0	54·7	11·6
October	45·8	5·7	27·7	5·9
November	27·0	3·4	7·6	1·6
December	11·7	1·5	2·0	0·4
YEAR	800·6	100·0	469·6	100·0

The percentage of crabs landed in the six summer months (April to September) amounts to 82·3 per cent. of the whole, and that of lobsters to 81·8 per cent. of the whole. It follows therefore that statistics based on the returns for the six summer months alone in successive years provide a sufficiently accurate basis from which to compare the productiveness of these fisheries in successive years. Indeed, it is probable that greater accuracy is ensured by this method than by taking the figures for the entire year, since the catches in the winter months depend less on the abundance of shell fish in the vicinity of the coast than on the prevalence or scarcity of stormy weather.

The next table shows the number of crabs and lobsters annually landed during the six summer months on the South Coast from 1886 to 1900.

TABLE IV., *showing the Number of Crabs and Lobsters landed on the South Coast during the six summer months (April to September) in each year from 1886 to 1900 (compiled from the Board of Trade's Returns).*

	Crabs (thousands).	Lobsters (thousands).
1886	471	281
1887	504	335
1888	514	279
1889	544	398
1890	571	499
1891	538	431
1892	603	478
1893	666	395
1894	679	367
1895	779	349
1896	869	416
1897	734	354
1898	880	405
1899	877	388
1900	596	319

It will be seen from the table that the yearly fluctuations in the returns for these months are almost identical in character with the fluctuations in the returns for the entire year given in Table II. The returns for the six summer months, however, in 1900 are seen to fall far below the returns for many years previously, both for crabs and lobsters, but especially for crabs. The number of crabs landed in 1900 is returned as 596 thousands, and that of lobsters 319 thousands. The returns for the previous year are, for crabs, 877 thousands, and for lobsters 388 thousands. The returns for 1900 accordingly show a diminution of 32 per cent. on the returns of the previous year as regards crabs, and of 18 per cent. as regards lobsters. These decreases are without parallel in the whole period of fifteen years covered by the Board of Trade's statistics, the nearest approach being afforded in the stormy year 1897, when the returns both for crabs and lobsters fell by 15 per cent. below those of the previous year. The number of crabs returned as landed on the South Coast in the summer months of the present year is actually lower than the number returned for any of the previous eight years, and of lobsters for any of the previous eleven years.

These figures therefore show in a marked manner the disastrous effect of the octopus plague on the shell fisheries of the South Coast during the present year. Unfortunately, it is not improbable that the ill effects may continue to be felt for several years to come, since a great destruction of shell fish, both mature and immature, must have taken place without directly affecting the statistics for the present year, though it may be expected to exert a depressing influence on the number of shell fish available for capture in succeeding years.

A feature of considerable interest in these statistics is the suddenness of the fall in 1900, although the first signs of the increase in the number of octopus on our coasts were manifested early in the preceding year. Bearing in mind the fact that the full effects of the plague were already experienced in the Channel Islands and on the French coast during the preceding year, and that there were no indications of any local increase in the numbers of octopus on our coasts prior to 1899, it seems exceedingly probable that the plague on our own coast is due to an actual invasion of octopus from the opposite shores of the Channel. This invasion began in 1899, but did not reach its height until the present year. The probable cause of the invasion, if this interpretation of the facts be accepted, is not far to seek. Enough is known about plagues in general to justify the statement that while they are in most cases attributable in the first instance to the effects of exceptionably favourable conditions for reproduction and survival, the migrations which subsequently take place are caused by the overcrowding and dearth of food which necessarily ensue in the original locality. I need only point to the well-ascertained facts concerning the plagues and migrations of lemmings* and locusts† in support of this statement.‡

The information we possess concerning the present plague of octopus points to a precisely similar conclusion—viz. an abnormal multiplication of these creatures on the French shores of the Channel and in the Channel Islands, dating back with some degree of probability to the year 1893, and followed in 1899, when the plague on the French coast had reached its height, by migrations outwards from the overcrowded centres of multiplication.

I have no detailed information as to the devastation effected by these creatures on the French coast (beyond the statement that they have done enormous damage to the shell fisheries in general), but the changes they have already wrought in our own waters are sufficient to show their probable character. In Plymouth Sound they have not only attacked the edible crabs (*Cancer pagurus*) and lobsters (*Homarus vulgaris*), but have temporarily exterminated the larger swimming crabs (*Portunus puber* and *depurator*) which in previous years have always been found in great abundance in the harbour. During the last few months it has been impossible to obtain more than isolated specimens in the shrimp trawl, although in previous years scores, and even hundreds, at a time could be obtained. In the Laboratory aquarium the octopus attacked and devoured all the specimens of the commoner British octopod, *Eledone cirrhosa*, which were living in the same tank.

III. Remedial Measures.

There is no reason to believe that the present plague of octopus will continue for more than one or two seasons, since the creature would long ago have established itself on our shores if the conditions had been suitable for its permanent residence. The species is a warm-water animal, and belongs, like many other occasional visitants of our south-western shores, to an assemblage of types which are distributed from the Mediterranean to the southern shore of the English Channel. The extension of these types to the north and east is usually limited by a line drawn from Start Point to the Cherbourg peninsula. As types of this fauna may be mentioned the ormer or ear-shell (*Haliotis tuberculata*), the crayfish (*Palinurus vulgaris*), the cotton-spinner (*Holothuria nigra*), and the pilchard or sardine (*Clupea pilchardus*). The barrier to the north-east, constituted roughly by the Start-to-Cherbourg line, is largely one of temperature. Eastward of that line the mean yearly temperature

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[*] Collett, *Myodes lemmus, its Habits and Migrations in Norway.* Christiania Videnskabs-Selskabs Forhandlinger, 1885, No. 3.

[†] Munro, *The Locust Plague and its Suppression*, London, 1900.

[‡] Cf. Latter, *The Recent Plague of Wasps*, Natural Science, iii., Oct., 1893, p. 273; also cf. vi., 1895, p. 178.

of the sea along the whole English coast from Start Point to the Straits of Dover is very slightly in excess of 52° Fahr., as recently determined by Dickson;* whereas west of that line the mean annual temperature of the coastal waters on the English coast rises from 52°·1 at the Start to 53°·9 in the Scilly Isles.

On the French coast the mean temperature is naturally somewhat higher than the temperature even of Devonshire and Cornish waters, and is not usually subject to so much depression during the winter months. It is probably this difference which, more than any other, renders impossible the permanent acclimatisation on the Devonshire and Cornish coasts of animals which are common on the opposite shores and rarely found on our own. The warm summers and mild winters which we have recently experienced have enabled the octopus temporarily to maintain themselves on our shores under pressure of the exceptional circumstances prevailing on the French coast; but the normal conditions of temperature will, in all probability, reassert themselves during the next year or two, in which case the disappearance of the octopus will almost certainly ensue.

Great damage to the shell fisheries may unfortunately take place in the meantime, and it is very desirable that the situation should be carefully considered. If the figures given in Table I., p. 265, afford any indication of the injury done to the fisheries in other localities as well as Plymouth, the question arises whether it would not be better for the fishermen to suspend all fishing for crabs and lobsters during the continuance of the plague, and to turn their attention temporarily to other kinds of fishing. By continuing to set their baited pots for shell fish they will obtain very meagre catches of uninjured crabs and lobsters so long as the octopus abound, and will at the same time place a far larger number at the mercy of the octopus without any chance of escape. As shown in Table I., fourteen out of every seventeen crabs and lobsters caught in October fell victims to the octopus, whereas if they had not been imprisoned in the fishermen's pots they would have been free to avail themselves of their natural methods of concealment and protection. Many of those which are now killed in the fishermen's pots would doubtless survive under natural conditions until the octopus disappear again, and would thus add to the breeding stock next year. It is to be feared that this stock, as well as the abundance of young crabs, must have been seriously reduced during the past summer. It is consequently to the fishermen's own interests to avoid all unnecessary waste of those which remain, since it is on them that the fisheries depend for their replenishment during the coming years.

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* H. N. Dickson, *Q. J. R. Met. Soc.*, xxv., Oct., 1899.

The one advantage which results from a continuance of the fishing is that the fishermen are thereby enabled to catch and destroy large numbers of octopus which are taken in their pots, and this in itself is of much importance. If a single fisherman, in the ordinary course of his work, as shown in Table I., can catch sixty-four octopus in a week, an appreciable reduction can be made in their numbers by the labours of ten or a dozen fishermen similarly employed.

On the Continent, however, and especially in the Mediterranean, where these octopods are regularly fished and sold for food, it is found that they can be caught in unbaited earthenware pots or vases, provided these are of a shape and size suitable for the octopus to enter and take shelter in. The pots appear usually to be pitcher-shaped, with a globular body about 12 inches and a neck about 3 or 4 inches in diameter. These are attached by cords to a line at fixed intervals, and the whole is then lowered to the bottom and buoyed for subsequent recognition. The line is hauled up every few days, and a certain number of octopus are found to have taken up their residence in the empty pots. They can thus be removed and killed without involving any sacrifice of valuable shell fish in the process.

In places where the octopus abound, *e.g.* at Marseilles, three or four men are permanently employed at a small subsidy in the sole work of catching them by the above and similar devices.

The question therefore arises whether similar means could not be used with advantage during the present crisis on the Devonshire and Cornish coasts; and, if so, whether the Sea Fisheries Committees of the two counties might not obtain authority to temporarily subsidise those *boná fide* crab fishermen who would give up their ordinary mode of fishing to devote themselves for a time to the work of exterminating the octopus by such means.

I hope that by the time these remarks are published I may be in a position to state the results of experiments on these lines which are now in progress in Plymouth Sound.

Notes and Memoranda.

Gadus esmarkii (*Nilss.*) **in shallow water.** A living specimen of this fish was taken on August 27th, 1900, in a tuck-net worked by Mr. T. Curtis on the shore of the Hamoaze, off Coombe Lake, between Saltash and the mouth of the River Lynher. Associated with it were numbers of mackerel, garfish, and young gadoids. Owing to its "bastard" characters, which struck the eye of the fisherman when handling it, the specimen was brought to the Laboratory for examination. Its capture is interesting for several reasons. It is the first specimen of Esmark's Pout recorded from the English Channel, and the only specimen hitherto obtained in littoral water, at any rate in the British area. The previous British records are enumerated in Holt's papers in *Trans. Roy. Dublin Soc.* v. 1895, p. 431, and this Journal, vol. v. 1897, p. 79. The dimensions and fin-ray formula of this specimen are given below, together with those of the less mutilated specimen from the Bristol Channel referred to by Holt in the second of his papers.

	Specimen from	
	Hamoaze.	Bristol Channel.
	mm.	mm.
Length, without caudal rays	168	167
,, with ,,	181	180
Depth, maximum	35	Shrunken
,, min. (caudal peduncle)	8	8
Length of head	39·5	37
Diameter of eye	13	12
Length of snout (preorbital)	10	9
Interorbital breadth	9	7
Fin-rays—$D_1 + D_2 + D_3$	15 + 24 + 24	15 + 28 + 27
,, $A_1 + A_2$	26 + 25	29 + ?

It will be observed that in the proportions of the eye and head ($= 1/3$) these southern specimens agree with the Norwegian type (Smitt, *Scandinavian Fishes*, 1892, p. 502), but that the ratio of length to depth of body falls below the minimum ratio assigned to this character for Scandinavian specimens by Smitt. The figures given by this authority show that the total length varies between 5·1 and 5·9 times the depth. In the Plymouth specimen the length is only 4·8 times the depth, thus approximating to the proportions of most of the Scottish and Irish specimens described by Günther and Holt ($4\frac{1}{2}$ times). It would therefore appear that in spite of occasional exceptions, such as those recorded by Holt, there is a general tendency in the British samples of *Gadus esmarkii* to the assumption of a stouter and less slender shape of body than in the Scandinavian type. So far as the Plymouth specimen is concerned this relation is also confirmed by the relatively greater depth of the caudal peduncle. The body length is only 21 times the depth of the peduncle, whereas in Scandinavian specimens, according to Smitt, the body is so attenuated that the length varies between 22·2 and 25 times the minimum depth of the body. Günther's figure of a Scottish specimen, on the other hand, yields a ratio of 24·5 times the caudal peduncle (*Proc. Roy. Soc. Edin.* xv. 1889, Plate III.).

The fin-ray formulæ present no distinctive features, since they happen to coincide closely in the two fishes examined with the minimum and maximum limits of variation assigned to Scandinavian specimens by Smitt. The maximum number of rays (38) attributed by Smitt to the second anal fin is clearly a misprint for 28.

It follows from the above that the only difference between the British and Norwegian samples of *Gadus esmarkii* that is revealed by the available data is a greater range of variation in the relative size of the eye and depth of the body in British than in Scandinavian specimens, a difference that may possibly be reduced upon examination of these points in a larger number of Scandinavian specimens.

WALTER GARSTANG.

An albino Hake (*Merluccius merluccius*). During the first week of October, 1900, Mr. J. C. Ward, Director of the Milford Docks Company, sent me, at the request of the captain of one of the steam trawlers, a specimen of a fish which came up in the trawl amongst a catch of hake, and was presumed to belong to some different and unfamiliar species. It was hakelike in form and structure, but much leaner in appearance, and entirely destitute of the usual skin pigmentation, both on the external surface of the body and on the inner linings of the buccal cavity and gill covers.

As a white-mouthed hake (*Merluccius argentatus*) has been recorded from the Icelandic coast by Faber (*fide* Günther, *Catalogue of Fishes*, iv. p. 346), I examined this specimen in some detail, half expecting it to throw light on the somewhat dubious Icelandic form. In all structural respects, however, the specimen agreed with the common hake, the teeth being normal, the scales forming about 135 rows, and the fin-ray formula being D. 10 + 39; A. 38. The pigmentation of the retina and peritoneum was also normal. The specimen was clearly, therefore, a white-skinned abnormality of the common hake, and offered no approach either to the Icelandic or New England hake, as regards an exceptionally large number of fin-rays.

The lean and emaciated condition of the specimen was, however, very striking, especially in the head region, where not only the bony ridges of the skull and cheeks projected sharply beneath the thin layer of skin, but even the lines of sculpture of the superficial bones were plainly recognisable. In a normal hake, with which I compared the specimen, these details were quite invisible, and the bony ridges were rounded off or hidden by the plumpness of the integument. In girth and weight the albino was far inferior to the normally pigmented hake of approximately equal length, as the following figures reveal:—

	Albino.	Normal (dusky) hake.
Length, to base of caudal fin	26¼ ins.	27½ ins.
Length of head (snout to opercular spine)	6¼ ,,	6¼ ,,
Interorbital breadth	1⅝ ,,	1¾ ,,
Girth round head, just in front of pelvic fins	9 ,,	10⅛ ,,
Girth just behind the tenth anal fin-ray	9⅛ ,,	10¼ ,,
Weight (gutted)	4 lb. 5 oz.	5 lb. 9½ oz.

These data show that, although the length of the albino was only 4½ per cent. less than that of the normal hake, the deficiency in girth amounted to 11 per cent. and the deficiency in weight to 23 per cent.

As the fish showed no signs of disease, I believe its lean condition may be attributed with some confidence to the check placed upon its catching powers by its conspicuous white colouration. Being a predacious and nocturnal fish, the hake must depend largely for its success in catching mackerel and other active prey upon its dusky inconspicuous appearance. A white hake, on the other hand, would be more easily avoided, especially at night, and would therefore catch fewer fish. Hence the emaciated condition of this albino is particularly interesting from the evidence it seems to afford of the operation of natural selection as regards the colouration of fishes.

In drawing this conclusion I have not overlooked the possibility that the deficiency in skin pigment may have involved a thinning of the skin, either as a physiological or congenital correlate, especially as in the New England hake (*M. bilinearis*), which appears to be less darkly pigmented than the European species, the ridges on the head are described as being very conspicuous (Jordan and Evermann, *Fishes of North America*, 1898, p. 2,530). The relative deficiency in the weight of this albino fish appears to be far too great to admit of this interpretation.

WALTER GARSTANG.

Marine Biological Association of the United Kingdom.

Report of the Council, 1899–1900.

The Council and Officers.

The four usual quarterly meetings of the Council have been held during the year, at which the average attendance has been eight. Three meetings have been held at the rooms of the Royal Society, and one at the rooms of the Zoological Society. The Council desires to express its thanks to both Societies for the hospitality shown.

The Council has to record with deep regret the death of two of its Vice-Presidents, both of whom took an active part in the foundation of the Association in 1884, and have since that time taken great interest in its welfare—His Grace the Duke of Argyll and Sir William Flower, K.C.B.

The Plymouth Laboratory.

The buildings, fittings, and machinery at Plymouth are in good order, with the exception of the small gas engine, the condition of which is receiving the attention of the Council. The Laboratory is adequately provided with the necessary apparatus for advanced research.

Arrangements have been made for supplying sea-water, obtained from the open sea beyond the Plymouth Breakwater, for special experiments on the rearing of sea-fishes and other marine animals. A tank-boat, having a carrying capacity of about 1,200 gallons, has been purchased, and a Tangye's pump fixed near the shore, by means of which the water is pumped from the boat to tanks placed on the upper story of the west wing of the Laboratory building. From these tanks the water is run through glass tubes to the main laboratory. The woodwork of the tanks is not yet seasoned, and a practical trial of the system has up to the present not been attempted.

The Boats.

The steamboat *Busy Bee* is in good order, and has not caused much expense for repairs during the year. Owing to the great increase in the price of coal it was found necessary to lay her up for a period during the winter, and the collecting work was then done by the sailing boat *Anton Dohrn*.

Through the kindness of Mr. J. W. Woodall the Association has had placed at its disposal for the present summer the hull of a small sailing yacht, the *Dawn*, which is being fitted up as a floating laboratory, for the purpose of investigating the fauna of the different harbours in the neighbourhood. This boat is at present stationed at Salcombe.

The Staff.

No change has taken place in the salaried staff during the year, which now consists of the Director (Mr. E. J. Allen), the Naturalist in charge of Fishery Investigations (Mr. W. Garstang), and the Director's Assistant (Mr. R. A. Todd). The Council considers that further development of the work of the Association must depend chiefly upon the provision of funds for a substantial increase in the number of naturalists permanently engaged in carrying out investigations. With the staff at its present numerical strength it is impossible to make full use of the facilities for research provided by the Laboratory and its equipment; for although the number of voluntary workers is not inconsiderable, the periods for which they remain at the Laboratory are generally short. Several additional naturalists might be permanently employed at Plymouth without any great additional expense beyond that of their salaries.

Occupation of Tables.

In addition to the Officers employed by the Association, the following naturalists have been engaged in research work at the Plymouth Laboratory during the year:—

W. M. ADERS, Marburg (Hydrozoa).
W. I. BEAUMONT, B.A., Cambridge (Nemertina and Mysidæ).
G. P. BIDDER, B.A., Cambridge (Sponges).
E. T. BROWNE, B.A., University College, London (Medusæ).
C. FORSTER COOPER, Cambridge (General Zoology).
W. F. COOPER, Cambridge (General Zoology).
H. FAGAN, Cambridge (General Zoology).
N. B. HARMAN, B.A., M.B., Cambridge (Fishes).
M. D. HILL, M.A., Oxford (Alcyonium).
J. KIMUS, Ph.D., Louvain (Crustacea).
W. SAVILLE KENT, London (Fishes).
W. F. LANCHESTER, B.A., Cambridge (Phoronis).
Prof. E. W. MACBRIDE, M.A., Montreal (Echinoderma).
Prof. E. A. MINCHIN, M.A., University College, London (Sponges).
Miss E. G. PHILIPPS, Newnham, Cambridge (Polyzoa).
R. C. PUNNETT, B.A., Cambridge (Elasmobranchs).
A. WILLEY, D.Sc., London (Polychæta).
R. N. WOLFENDEN, M.D., Cambridge (Plankton).
H. M. WOODCOCK, University College, London (Hydrozoa).

Twelve students from Oxford, Cambridge, and Eton attended Mr. Garstang's vacation class in Marine Biology.

The Library.

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the year :—

Transactions and Proceedings of the Royal Society of London.
Transactions and Proceedings of the Zoological Society of London.
Zoological Record.
Report of the British Association for the Advancement of Science. (Dover, 1899.)
Journal of the Royal Microscopical Society.
Quarterly Journal of Microscopical Science. (Presented by Messrs. J. and A. Churchill.)
Proceedings of the Fourth International Congress of Zoology. (Cambridge, 1898.)
Report of H.M. Inspectors of Fisheries. (*England and Wales.*)
Catalogue of the Radcliffe Library, Oxford.
Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands, and elsewhere. Dr. A. Willey.
The Cambridge Natural History. (Presented by the Editors.)
Transactions of the Scottish Natural History Society.
Proceedings of the Scottish Microscopical Society.
Report of the Millport Marine Biological Station.
Annual Report of the Fishery Board for Scotland.
Studies from the Marine Laboratory of the Royal Dublin Society.
Proceedings of the Royal Irish Academy.
Proceedings and Transactions of the Liverpool Biological Society.
Report of the Port Erin Biological Station.
Lancashire Sea Fisheries Committee. *Superintendent's Report.*
Studies in Biology from Owens College, Manchester.
Northumberland Sea Fisheries Committee. *Report on Trawling Excursions.*
Proceedings of the Bristol Naturalists' Society.
Cornwall County Council. *Report of the Lecturer on Fishery Subjects.*
Rousdon Observatory. Meteorological Observations.
Annual Reports of the Department of Marine and Fisheries, Canada.
Bulletin of the Natural History Society of New Brunswick.
Annals of the South African Museum.
Cape of Good Hope Department of Agriculture. *Report of the Marine Biologist.*
Illustrations of the Zoology of the Royal Indian Marine Survey Ship "Investigator."
Administration Report of the Madras Government Museum.
Memoirs of the Bernice Punahi Bishop Museum.
Proceedings of the Linnæan Society of New South Wales.
Australian Museum, Sydney. *Report of Trustees.*
Australian Museum, Sydney. *Memoir IV.; Catalogue XVII., Tunicata.*
Records of the Australian Museum.
Proceedings of the Royal Society of Victoria.
Fauna Hawiiensis.
Bulletin du Museum d'Histoire Naturelle, Paris.
Statistique des Pêches Maritimes.
Bulletin de la Marine Marchande.

Bulletin Scientifique de la France et de la Belgique.

Mémoires de la Société Zoologique de France. Bulletin de la Société Zoologique de France.

Congrès International de Pêches. Maritimes. (Dieppe, 1898.)

Bulletin de la Société Centrale d'Aquiculture et de Pêche.

La Feuille des Jeunes Naturalistes.

La Pisciculture Pratique.

Le Mois Scientifique.

Wissenschaftliche Meeresuntersuchungen. Aus der Biologischen Anstalt auf Helgoland.

Mittheilungen des Deutschen Seefischerei-Vereins.

Allgemeine Fischerei-Zeitung.

Mittheilungen aus dem Naturhistorichen Museum in Hamburg.

Bulletin de l'Académie Impériale des Sciences de St. Petersbourg.

Bulletin du Laboratoire Biologique de St. Petersbourg.

Russian Fishery Journal.

Mittheilungen des Kaukasischen Museums.

Revue Internationale de Pêche et de Pisciculture.

Acta Societatis pro Fauna et Flora Fennica.

Norwegian North Atlantic Expedition Reports.

Archiv for Mathematik og Naturvidenskab.

Bergens Museums Aarbog.

An Account of the Crustacea of Norway. By G. O. Sars. (Bergens Museum.)

Norsk Fiskeritidende.

Svensk Fiskeri Tidskrift.

Det Kongelige Norske Videnskabers Selskabs Skrifter.

Bihang till Kongl. Svenska Vetenskaps Akademiens Handlingar.

Selskabet for de Norske Fiskeriers Fremme.

Mittheilungen aus der Zoologischen Station zu Neapel.

La Nuova Notarisia.

Mémoires de l'Académie Royal des Sciences et des Lettres de Danemark.

Bulletin de l'Académie Royale des Sciences et des Lettres de Danemark.

The Danish Ingolf Expeditions. Zoological Museum, Copenhagen.

Report of the Danish Biological Station to the Board of Agriculture. Dr. C. G. J. Petersen.

Beretning fra Kommissionen for Videnskabelig Undersögelse af de danske Fravande.

Verslag van den Staat der Nederlandsche Zee Visscherijen.

Mededeelingen over Visscherij.

Tijdschrift der Nederlandsche Dierkundige Vereeniging.

Het Zoölogisch Station der Nederlandshe Dierkundige Vereeniging. Dr. P. P. C. Hoek.

La Cellule.

Bulletin de la Sociétié Belge de Géologie.

Annales du Musée du Congo.

Estatica das Pescas Maritimas. Portugal.

Revista de Pesca Maritima.

Bulletin and Report of the United States Commission of Fish and Fisheries.

Bulletin and Memoirs of the Museum of Comparative Zoology at Harvard College.

Annual Report of the Smithsonian Institution. United States National Museum.

Bulletin of the United States National Museum.

Proceedings of the United States National Museum.

Bulletin and Annual Report of the American Museum of Natural History.

Annals of the New York Academy of Sciences.
Memoirs from the Biological Laboratory of the Johns Hopkins University.
Bulletin of the Laboratories of Natural History, State University of Iowa.
Bulletin of the Illinois State Laboratory.
Publications of the Field Columbian Museum.
Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University.
Proceedings of the Boston Society of Natural History.
Bulletin of the Buffalo Society of Natural Sciences.
Comunicaciones del Museo Nacional de Buenos Aires.
Annales del Museo Nacional de Montevideo.
Revista Chilena de Historia Natural.
Journal of the College of Science, University of Tokyo.
Annotationes Zoologicae Japonenses.
Journal of the Fisheries Society of Japan.
Report of Fisheries Institute. Department of Commerce and Agriculture. Japan.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library :—

Report on the Xeniidae collected by Dr. Willey. J. H. Ashworth.
The Epidermis of Tubifex rivulorum, *Lamarck, with Especial Reference to its Nervous Structures.* L. Atheston.
A Contribution to the Anatomy of the Digestive Tract in Salmo salar. J. K. Barton.
On the Formation of Coral Reefs on the N.W. Coast of Australia. P. W. Bassett-Smith.
Record of Echinoderma. F. A. Bather.
The Fauna of the Sound. From the Swedish of Dr. E. Lönnberg, by F. A. Bather.
A Book of Whales. F. E. Beddard. Presented by Dr. Russel Rendle.
On the Occurrence of Gobius capito *on the Coast of Brittany.* G. A. Boulenger.
The Elimination of the Unfit as illustrated by the introduced Sparrow. H. C. Bumpus.
The Breeding of Animals at Woods Holl. H. C. Bumpus.
On the Reappearance of the Tile-fish. H. C. Bumpus.
Résultats Scientifiques de la Campagne du "Caudan." Copépodes. E. Canu.
Note sur les Copépodes et les Ostracodes Marins des Cotes de Normandie. E. Canu.
Le Tarif des Douanes et la Conservation des harengs congelés au moyen du Mélange de Sel et de Glace. E. Canu.
La Pêche a Boulogne. E. Canu.
Plankton Researches in 1897. P. T. Cleve.
On the Seasonal Distribution of some Atlantic Plankton Organisms. P. T. Cleve.
On the Origin of Gulf-stream Water. P. T. Cleve.
Some Atlantic Tintinnodea. P. T. Cleve.
Recherches sur les Aphroditiens. J. G. Darboux.
The Mean Temperature of the Surface Waters of the Sea round the British Coasts and its Relation to the Mean Temperature of the Air. H. N. Dickson.
Von der Allgemeingiltigkeit Wissenschaftlicher Aussagen. H. Driesch.
Resultate und Probleme der Entwickelungsphysiologie der Thiere. H. Driesch.
Studien über das Regulationsvermögen der Organismen. H. Driesch.
Haben die Fische ein Gedächtniss. L. Edinger.
Notes on Tectibranchs and Naked Molluscs from Samoa. C. Eliot.

The Power of Colour-change in Animals. F. W. Gamble.

Directions to Fishermen for Increasing the Stock of Fish on the Fishing Grounds. W. Garstang.

Miscellanées Biologiques dédiées au Professeur A. Giard a l'occasion du XXVE Anniversaire de la Foundation de la Station Zoologique de Wimereux.

Coup d'œil sur la Faune et note sur la Flore du Boulonnais. A. Giard.

La Station Zoologique de Wimereux. A. Giard.

The Palpebral and Oculomotor Apparatus in Fishes. N. Bishop Harman.

Zur Kentniss der Gattungen Margelopsis and Nemopsis. C. Hartlaub.

Beiträge zur Fauna der Südöstlichen und Ostlichen Nordsee. Dr. Fr. Heincke.

Oysters and Disease. Lancashire Sea Fisheries Memoirs. W. A. Herdman and R. Boyce.

The Medusæ of Millepora. S. J. Hickson.

Zoophytes. Presidential Address, Manchester Microscopical Society. S. J. Hickson.

The Stolonifera and Alcyonacea collected by Dr. Willey. S. J. Hickson and I. Hiles.

Neuere Lachs-und Maifisch-Studien. P. P. C. Hoek.

Recherches sur la Reproduction des Poissons osseux. E. W. L. Holt.

On the Nephridium of Nephthys cæca. F. H. Hughes.

The True Nature of Mobiusispongia parasitica, *Duncan.* A. V. Jennings.

On a new Genus of Foraminifera of the Family Astrorhizidæ. A. V. Jennings

On the Structure of the Isopod Genus Ourozeuktes. A. V. Jennings.

The Structure of the Forest of Wyre Coal-Field. D. Jones.

On the Nauplius stage of Penaeus. K. Kishinouye.

Contributions to the Natural History of the Commander Islands. K. Kishinouye.

The Sense-organs of Nereis virens, *Sars.* F. E. Langdon.

The Development of Echinoids. E. W. MacBride.

The Movements of Copepods. E. W. MacBride.

Dictionary of the Lepcha language. Gen. G. B. Mainwaring.

Description d'une espèce nouvelle du genre Potamon, Sav., provenant du pays des Somalis. J. G. de Man.

Note sur quelques Thelphusidés recueillis par M. Pavie dans l'Indo-Chine. J. G. de Man.

Note sur quelques espèces des genres Parathelphusa, H.M-E. et Potamon, Sav., recueillis par M. Leonardo Fea pendant son voyage en Bermanie. J. G. de Man.

*Note sur quelques espèces du genre Alpheus, Fabr. appartenant a la section dont l'*Alpheus Edwardsi, *Aud., est le representant.* J. G. de Man.

The Maturation, Fertilization, and Early Development of the Planarians. W. G. van Name.

Manual de Ictiologia Marina. D. A. Navarrete.

On British Species of Siphonostoma. M. J. Newbigin.

2-den beretning om de ved den biologiske station i Bergen foretagne udklaekningsforsög med lakserogn i saltvand. O. Nordgaard.

Notes on Montagu's Hunting Ground, Salcombe Bay. A. M. Norman.

Revision of British Mollusca. A. M. Norman.

Cucumaria Montagui *(Fleming) and its Synonymy.* A. M. Norman.

A Month on the Trondhjem Fiord. A. M. Norman.

Holothuria nigra, *Gray, and its Synonymy.* A. M. Norman.

La Riduzione Progressiva della Variabilita e i suoi Rapporti coll' Estinzione e coll' Origine delle Species. D. Rosa.

Les Cutlériacées et leur Alternance de Générations. M. C. Sauvageau.

Note Preliminaire sur les Algues Marines du Golfe de Gascoyne. C. Sauvageau.

Les Acinetospora. C. Sauvageau.
A List of Irish Cetacea. R. F. Scharff.
The History of the European Fauna. R. F. Scharff.
Address to the Zoological Section, British Association, Dover, 1899. A. Sedgwick.
On a collection of Echiurids from the Loyalty Islands, New Britain and China Straits. A. E. Shipley.
Notes on the Species of Echinorhynchus parasitic in the Cetacea. A. E. Shipley.
The Death Temperature of Certain Marine Organisms. H. M. Vernon.
Heat Rigor in Cold-blooded Animals. H. M. Vernon.
The Effect of Staleness of the Sexual Cells on the Development of Echinoids. H. M. Vernon.
The Marine Biological Stations of the World. H. B. Ward.
Protoplasmic Contractility and Phosphorescence. S. Watasé.

Amongst a large number of pamphlets from the library of the late Rev. Thomas Hincks, presented to the Association by Mrs. Hincks, and forming a valuable addition to those purchased last year from the same source, are:—

A notice of some new genera and species of British Hydroid Zoophytes. J. Alder.
Descriptions of three new and rare British Zoophytes on the Coast of Northumberland. J. Alder.
Descriptions of two new species of Sertularian Zoophytes. J. Alder.
Reports on Deep Sea Dredgings on the Coasts of Northumberland and Durham. H. B. Brady.
A monograph of the recent British Ostracoda. H. B. Brady.
On the development of decapod Crustacea. Spence Bate.
The General History of the Cephalopoda, Recent and Fossil. A. Crane.
Description of Peachia hastata*; a new genus and species of the class Zoophyta.* P. H. Gosse.
On the diœcious character of the Rotifera. P. H. Gosse.
On the Anatomy and Physiology of the Tunicata. A. Hancock.
Reprints of many papers by Rev. T. Hincks.
Études sur les Éponges de la mer Blanche. C. Mereschkowsky.
Reprints of many papers by Rev. A. M. Norman.
Monograph of the Genus Isocardia. L. Reeve.
Reprints of several papers by Rev. T. R. R. Stebbing.
Some remarkable forms of Animal Life from great depths off Norway. G. O. Sars.
Middelhavets Mysider. G. O. Sars.
Catalogue of the Land and Freshwater Mollusca of Ireland. W. Thompson.
Preliminary Check-list of the Marine Invertebrata of the Atlantic Coast from Cape Cod to the Gulf of St. Lawrence. A. E. Verrill.
On the Urticating filaments of the Aeolidae. T. S. Wright.

General Report.

The periodical surveys of the physical and biological conditions prevailing at the mouth of the English Channel, which were undertaken last year by Mr. Garstang in order to throw light on the migrations of the mackerel and other fishes, have been continued, at quarterly intervals, for an entire year. Five surveys altogether were made, from February, 1899, to March, 1900. The same route was taken on each voyage, viz. from Plymouth to Ushant, with a station in mid-Channel; from Ushant to the westward about fifty miles (near Parson's Bank); from the latter station northwards to Mount's Bay; and from the Mount's Bay station back to Plymouth. At each station systematic observations were made for comparative purposes by identical methods and instruments. They included serial temperature determinations at all depths, filtration of a definite column of water from bottom to surface with a "vertical net" (for estimating the varying abundance of minute plant and animal life), and collections of the floating life at surface, midwater, and bottom by means of a specially devised "closing net," which worked with great precision. The collections brought home on the different voyages are now under examination, and will be reported upon in due course. The expense of steamboat hire (£140) in connection with these experiments has been met by special grants from the British Association at the Bristol and Dover meetings.

Mr. Garstang has also carried out a series of preliminary experiments on the rearing of sea-fish larvæ under different conditions, with a view to a solution of the difficulties hitherto encountered in regard to the practical work of sea-fish culture. His experiments led to definite and satisfactory conclusions, proving the necessity of agitated water to the larvæ in their early stages, and resulting in the healthy metamorphosis and survival of an unprecedented proportion of the fry (above 50 per cent.). Structural alterations, already described, have been made in the Plymouth Laboratory, with a view to a repetition of these experiments on a larger scale with the larvæ of food-fishes.

An independent examination of the experimental and statistical evidence which bears on the alleged depletion of the trawling grounds has also been made by Mr. Garstang, which leaves little, if any, room for doubt that the fisheries for the more valuable flat-fish at any rate (prime fish and plaice) are undergoing a process of exhaustion in consequence of over-fishing. Mr. Garstang's report on this subject includes the first elaborate attempt to measure the growth of catching power in the English deep-sea trawl and line fisheries since the introduction of steam in the fishing industry. A detailed report will shortly appear in the Journal of the Association.

The investigation of the fauna and bottom-deposits of the shallow-water grounds in the neighbourhood of Plymouth, upon a plan similar to that followed in the investigation of the grounds near the thirty-fathom line between the Eddystone and Start Point, has made considerable progress during the year. A large number of hauls of the trawl and dredge have been taken upon the area under examination, and the results have been systematically recorded. In these shallower waters the conditions are more complicated and variable than those met with at thirty fathoms, and some little time must elapse before the results of the research are sufficiently complete for publication.

The Laboratory has continued to supply preserved specimens of marine animals and plants to the Universities and other teaching institutions, as well as to a number of museums in different parts of the world. Many private workers have also been provided with specially-prepared material for their own researches. This specimen trade pays its own expenses, and is of considerable advantage to biological science in general, as well as to the Association.

Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association:—

BARNARD, J. E.—*Photogenic Bacteria.* Trans. Jenner Instit., 1899, ser. 2, p. 81.

GARSTANG, W.—*Plankton and Physical Conditions of the English Channel.* Report Brit. Assoc., 1899.

GARSTANG, W.—*Experiments on the Artificial Rearing of Sea-Fish.* Brit. Assoc. Rep., 1899.

HARMAN, N. B.—*The Palpebral and Oculomotor Apparatus in Fishes: observations on Morphology and Development.* Journ. Anat. and Phys., vol. xxxiv., 1899.

HOLT, E. W. L.—*Recherches sur la Reproduction des Poissons osseux.* Ann. Mus. Hist. Nat. Marseille, v. 1899.

HOLT, E. W. L., and BEAUMONT, W. I.—*Report on the Schizopoda of Ireland.* Sci. Trans. Roy. Dublin Soc. (Series II.), vol. vii., pt. vii., 1900.

TAYLOR, T. H.—*The Embryology of the Polyzoa.* Brit. Assoc. Rep., 1899.

MACBRIDE, E. W.—*The Development of Echinoids. Part I. The Larvæ* Echinus miliaris *and* Echinus esculentus. Quart. Journ. Micr. Sci., vol. xlii., 1899, p. 335.

MACBRIDE, E. W.—*The Rearing of Larvæ of Echinidæ.* Report Brit. Assoc., 1899.

MACBRIDE, E. W.—*The Movements of Copepoda.* Quart. Journ. Micr. Sci., vol. xlii., 1899, p. 505.

Donations and Receipts.

The Receipts for the year include the grants from H.M. Treasury (£1,000) and the Worshipful Company of Fishmongers (£400), Founder's Subscription (£100), Composition Fees (£15), Annual Subscriptions (£138), Rent of Tables in the Laboratory (£54), Sale of Specimens (£238), Admission to the Tank Room (£76). The total income for the year amounts to £2,059 19*s.* 4*d.* The Council desires to call attention to the statement made by Mr. Hanbury (*Times*, June 16th, 1900), and to observe that it is not the case that the Association is not in need of increased funds. The balance shown in the yearly accounts of the Association is no surplus, but merely the usual working balance of a current account.

Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1900–1901:—

President.

Prof. E. Ray Lankester, LL.D., F.R.S.

Vice-Presidents.

The Duke of Abercorn, K.G., C.B.
The Earl of St. Germans.
The Earl of Morley.
The Earl of Ducie, F.R.S.
Lord Avebury, F.R.S.
Lord Tweedmouth.
Lord Walsingham, F.R.S.
The Right Hon. A. J. Balfour, M.P., F.R.S.
Sir Edward Birkbeck, Bart.
The Right Hon. Joseph Chamberlain, M.P.
Sir Michael Foster, M.P., F.R.S.
A. C. L. Günther, Esq., F.R.S.
Sir John Murray, F.R.S.
Prof. Alfred Newton, F.R.S.
Rev. Canon Norman, D.C.L., F.R.S.
Sir Henry Thompson, Bart.
Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S.

Members of Council.

F. E. Beddard, Esq., F.R.S.
Prof. F. Jeffrey Bell.
G. P. Bidder, Esq.
G. C. Bourne, Esq., F.L.S.
G. Herbert Fowler, Esq.
S. F. Harmer, Esq., F.R.S.
Prof. W. A. Herdman, F.R.S.
Prof. G. B. Howes, F.R.S.
J. J. Lister, Esq., F.R.S.
Prof. E. A. Minchin.
D. H. Scott, Esq., F.R.S.
Prof. Charles Stewart, F.R.S.
Prof. D'Arcy W. Thompson, C.B.
Prof. W. F. R. Weldon, F.R.S.

Hon. Treasurer.

J. A. Travers, Esq.

Hon. Secretary.

E. J. Allen, Esq., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council:—

Robert Bayly, Esq.
J. P. Thomasson, Esq.
The Prime Warden of the Fishmongers' Company.
E. L. Beckwith, Esq. (Fishmongers' Company).
Prof. Sir J. Burdon Sanderson, Bart., F.R.S. (Oxford University).
A. E. Shipley, Esq. (Cambridge University).

Dr. *Statement of Receipts and Expenditure for the Year ending 31st May, 1900.* Cr.

Receipts.	£	*s.*	*d.*	£	*s.*	*d.*
To Balance from last year, being Cash at Bank and in hand				153	4	8
„ H.M. Treasury				1000	0	0
„ Fishmongers' Company				400	0	0
„ Founder's Subscription—G. P. Bidder, Esq.				100	0	0
„ Life Member's Composition Fee— The Hon. R. Guinness				15	15	0
„ Donation—J. W. Woodall, Esq.				5	5	0
„ Annual Subscriptions				137	9	0
„ Rent of Tables	54	9	0			
„ Sale of Specimens	237	16	3			
„ Sale of Journal, &c.	13	14	8			
„ Admissions to Tank Room	76	3	9			
				382	3	8
„ Interest on Investment	19	6	8			
				£2213	4	0

Expenditure.	£	*s.*	*d.*	£	*s.*	*d.*
By Salaries and Wages—						
Director	200	0	0			
Naturalist	250	0	0			
Director's Assistant	80	0	0			
Wages	536	11	2			
				1066	11	2
„ Stationery, Office Printing, Postages, &c.				103	0	3
„ Printing and Illustrating Journal				120	15	1
„ Outside Sea-water Plant— Purchase of and fixing Pumping Apparatus, Tanks, and Tank-boat				143	6	1
„ Sundry Expenses—						
Gas, Water, Coal, &c. …… £103 7 0						
Coal for Steam Yacht …… 50 4 10						
	153	11	10			
Insurance of Steam Yacht, including boiler	12	7	6			
Stocking Tanks, Feeding, &c.	59	5	1			
Glass, Chemicals, Apparatus, &c. …… £73 3 10						
Less Sales of Glass, &c. …… 9 6 5						
	63	17	5			
Maintenance and Renewal of Buildings	95	14	11			
Maintenance and Renewal of Boats and Nets …… £163 17 4						
Less Sale of Nets and Gear… 55 6 3						
	108	11	1			
Rates, Taxes, and Insurance	13	2	10			
Boat Hire	8	6	0			
Travelling Expenses	25	0	6			
Library	60	18	4			
				600	15	6
„ Balance forward, being Cash at Bank and in hand, 31st May, 1900				178	15	11
				£2213	4	0

Examined and found correct,

Edwin Waterhouse,
Frank E. Beddard,
G. Herbert Fowler,
} *Auditors.*

Investment held 31st May, 1900, £500 Forth Bridge Railway 4% Guaranteed Stock.

Marine Biological Association of the United Kingdom.

LIST
OF
Governors, Founders, and Members.

1st NOVEMBER, 1900.

I.—Governors.

The British Association for the Advancement of Science, *Burlington House, W.*	£500
The University of Cambridge	£500
The Worshipful Company of Clothworkers, 41, *Mincing Lane, E.C.*	£500
The Worshipful Company of Fishmongers, *London Bridge*	£4705
The University of Oxford	£500
Bayly, Robert, *Torr, Plymouth*	£1000
Bayly, John (the late)	£600
Thomasson, J. P., *Woodside, near Bolton*	£970

II.—Founders.

* Member of Council. † Vice-President. ‡ President.

1884	The Corporation of the City of London	£210
1884	The Worshipful Company of Mercers, *Mercers' Hall, Cheapside*	£341 5*s.*
1884	The Worshipful Company of Goldsmiths, *Goldsmiths' Hall, E.C.*	£100
1884	The Royal Microscopical Society, 20, *Hanover Square, W.*	£100
1884	The Royal Society, *Burlington House, Piccadilly, W.*	£350
1884	The Zoological Society, 3, *Hanover Square, W.*	£100
1884	Bulteel, Thos., *Radford, Plymouth*	£100
1884	Burdett-Coutts, W. L. A. Bartlett, 1, *Stratton Street, Piccadilly, W.*	£100
1884	Crisp, Frank, LL.B., B.A., Treas. Linn. Soc., 17, *Throgmorton Avenue, E.C.*	£100
1884	Daubeny, Captain Giles A., *Les Colondalles, Montreux, Switzerland*	£100
1884	Eddy, J. Ray, *The Grange, Carleton, Shipton, Yorkshire*	£100
1884	Gassiott, John P., *The Culvers, Carshalton, Surrey*	£100
*1884	Lankester, Prof. E. Ray, F.R.S., *British Museum (Natural History), South Kensington, S.W.*	£100
1884	Lister, S. Cunliffe, *Swinton Park, Masham, Yorkshire*	£100

†1884	Lord Avebury, F.R.S., *High Elms, Bromley, Kent*	£100
1884	Poulton, Prof. Edward B., M.A., F.R.S., *Wykeham House, Oxford*	£100
1884	Romanes, G. J., LL.D., F.R.S. (the late)	£100
1884	Worthington, James (the late)	£100
1885	Derby, the Rt. Hon. the late Earl of	£100
*1887	Weldon, Prof. W. F. R., F.R.S., *Merton Lea, Oxford*	£100
1888	Bury, Henry, M.A., *Trinity College, Cambridge*	£100
1888	The Worshipful Company of Drapers, *Drapers' Hall, E.C.*	£315
1889	The Worshipful Company of Grocers, *Poultry, E.C.*	£120
†1889	Thompson, Sir Henry, Bart., 35, *Wimpole Street, W.*	£110
1889	Revelstoke, The late Lord	£100
1890	Riches, T. H., B.A., *Kitwells, Shenley, Herts.*	£130
*1900	Bidder, G. P., 9, *Windsor Terrace, Plymouth*	£100

III.—Members.

ann. signifies that the Member is liable to an Annual Subscription of One Guinea.

C. signifies that he has paid a Composition Fee of Fifteen Guineas in lieu of Annual Subscription.

1897	Adams, W. R., 57, *Wood Vale, Lordship Lane, London, S.E.*	*ann.*
1900	Aders, W. M., 28, *St. John's Wood Road, London, N.W.*	*ann.*
1884	Alger, W. H., *Manor House, Stoke, Devonport*	*C.*
*1895	Allen, E. J., D.Sc., *The Laboratory, Plymouth*	*ann.*
1885	Armstrong, Lord, C.B., F.R.S., *Crag Side, Rothbury*	*C.*
1893	Ascroft, R. L., 11, *Park Street, Lytham, Lancs.*	*ann.*
1892	Assheton, R., *Granchester, Cambridge*	£20
1899	Auckland Lord, *Kitley, Plymouth*	*ann.*
1884	Bailey, Charles, F.L.S., *Ashfield, College Road, Whalley Range, Manchester*	*ann.*
1893	Bailey, W. E., *Porth Enys Museum, Penzance*	*C.*
1884	Balfour, Prof. Bayley, F.R.S., *Royal Botanic Gardens, Edinburgh*	*C.*
1893	Bassett-Smith, P. W., Staff-Surgeon, R.N., *R.N. Hospital, Haslar, Portsmouth*	*ann.*
1884	Bateson, Wm., F.R.S., *St. John's College, Cambridge*	*ann.*
1897	Baxter, G. H., *Hutton Road, Brentwood, Essex*	*ann.*
1884	Bayliss, W. Maddock, B.Sc., *St. Cuthberts, West Heath Road, Hampstead.*	*ann.*
1884	Bayly, Miss, *Seven Trees, Plymouth*	£50
1884	Bayly, Miss Anna, *Seven Trees, Plymouth*	£50
1897	Baynes, R. W., 4, *Saltram Place, Plymouth*	*ann.*
1884	Beaumont, W. I., B.A., *The Laboratory, Plymouth*	*ann.*
1885	Beck, Conrad, 68, *Cornhill, E.C.*	*C.*
*1889	Beckwith, E. L., *The Knoll, Eastbourne*	*ann.*
*1887	Beddard, F. E., F.R.S., *Zoological Society's Gardens, Regent's Park, N.W.*	*ann.*
1884	Beddington, Alfred H., 8, *Cornwall Terrace, Regent's Park, N.W.*	*C.*
1897	Bedford, Mrs., 326, *Camden Road, London, N.*	*ann.*
*1884	Bell, Prof. F. Jeffrey, 35, *Cambridge Street, Hyde Park, W.*	*ann.*
†1885	Birkbeck, Sir Edward, Bart., 10, *Charles Street, Berkeley Square, W.*	*ann.*
1893	Bles, A. J. S., *Palm House, Higher Broughton, Manchester*	*ann.*
1889	Bolitho, T. B., *Chyandour, Penzance*	*ann.*
1884	Bompas, G. C., 121, *Westbourne Terrace, Hyde Park, London, W*	*ann.*

1884	Bossey, Francis, M.D , *Mayfield, Redhill, Surrey*	*ann.*
1884	Bostock, E., *Stone, Staffordshire*	*ann.*
1890	Bourne, Prof. A. G., F.R.S., *The Presidency College, Madras*	*ann.*
*1884	Bourne, Gilbert C., M.A., *Savile House, Mansfield Road, Oxford*	*ann.*
1898	Bowles, Col. Henry, M.P., *Forty Hall, Enfield*	*ann.*
1895	Bridge, Prof. T. W., D.Sc., *University of Birmingham*	*ann.*
1890	Brindley, H. H., M.A., 6, *Richmond Road, Cambridge*	*ann.*
1886	Brooksbank, Mrs. M., *Leigh Place, Godstone, Surrey*	*C.*
1884	Brown, Arthur W. W., 37, *Evelyn Mansions, Carlisle Place, Victoria Street, S.W.*	*C.*
1893	Browne, Edward T., B.A., 141, *Uxbridge Road, W.*	*ann.*
1893	Buchanan, Miss Florence, B.Sc., *The Museum, Oxford*	*ann.*
1884	Buckton, G. B., *Weycombe, Haslemere*	*ann.*
1896	Bulstrode, H. P., M.D., 4, *The Mansions, Earl's Court, S.W.*	*ann.*
1887	Burd, J. S., *Cresswell, Higher Compton, Plymouth*	*ann.*
1889	Burnard, Robert, 3, *Hillsborough, Plymouth*	*ann.*
1897	Byrne, L. W., B.A., 33, *Lancaster Gate, London*	*ann.*
1884	Caine, H. T., 5, *Upper Wimpole Street, London, W.*	*C.*
1884	Caine, W. S., *The Terrace, Clapham Common, S.W.*	£21
1887	Caldwell, W. H.	*C.*
1884	Canterbury, His Grace the Archbishop of, *Lambeth Palace, S.W.*	*ann.*
†1884	Chamberlain, Rt. Hon. J., M.P., 40, *Prince's Gardens, S.W.*	*ann.*
1884	Christy, Thomas Howard	*ann.*
1887	Clarke, Rt. Hon. Sir E., Q.C., 5, *Essex Court, Temple, E.C.*	£25
1884	Clay, Dr. R. H., *Windsor Villas, Plymouth*	*ann.*
1885	Clerk, Major-General H., F.R.S., "*Mountfield*," 5, *Upper Maze Hill, St. Leonards-on-Sea, Sussex*	£21
1886	Coates and Co., *Southside Street, Plymouth*	*C.*
1885	Collier Bros., *Old Town Street, Plymouth*	*C.*
1900	Cooper, W. F., B.A., *Ashlyns Hall, Berkhamsted*	*ann.*
1889	Crossman, Major-General Sir William, K.C.M.G., *Cheswick, Beal, R.S.O., Northumberland*	*ann.*
1885	Darwin, Francis, F.R.S., *Botanical Laboratory, Cambridge*	*C.*
1885	Darwin, W. E., *Ridgemount, Bassett, Southampton*	£20
1889	Davies, H. R., *Treborth, Bangor*	*ann.*
1884	Dewick, Rev. E. S., M.A., F.G.S., 26, *Oxford Square, Hyde Park, W.*	*C.*
1885	Dixey, F. A., M.A., Oxon., *Wadham College, Oxford*	£26 5*s.* *and ann.*
1890	Driesch, Hans. Ph.D., *Philosophenweg* 5, *Heidelberg, Germany*	*C.*
†1889	Ducie, The Rt. Hon. the Earl of, F.R.S., *Tortworth Court, Falfield, R.S.O.*	£50 15*s.*
1884	Dunning, J. W., 4, *Talbot Square, W.*	£26 5*s.*
1884	Dyer, Sir W. T. Thiselton, M.A., K.C.M.G., F.R.S., *Director of the Royal Gardens, Kew*	*C.*
1893	Edward, S. Stanley, F.Z.S., *Kidbrook Lodge, Blackheath, S.E.*	*ann.*
1898	Eliot, Sir C. N. E., K.C.M.G., C.B., *British Agency, Zanzibar*	*ann.*
1891	Ellis, Hon. Evelyn, *Rosenais, Datchet, Windsor*	*C.*
1893	Enys, John Davies, *Enys, Penryn, Cornwall*	*ann.*
1884	Evans, Sir John, D.C.L., F.R.S., *Nash Mills, Hemel Hempstead*	£20
1885	Ewart, Prof. J. Cossar, M.D., *University, Edinburgh*	£25

1894 Ferrier, David, M.A., M.D., F.R.S., 34, *Cavendish Square, W.* ann.
1884 Fison, Frederick W., *Greenholme, Burley-in-Wharfedale, Leeds* C.
1897 Foster, Richard, *Windsworth, Looe, R.S.O.* ann.
*1885 Fowler, G. Herbert, B.A., Ph.D., 5, *Pyrland Road, Richmond, London, S.W.* ann.
1884 Fox, George H., *Wodehouse Place, Falmouth* ann.
1886 Freeman, F. F., *Abbotsfield, Tavistock, S. Devon* C.
1884 Fry, George, F.L.S., *Carlin Brae, Berwick-on-Tweed* £21
1884 Fryer, Charles E., *Board of Trade, S.W.* ann.

1898 Ganz, C., 5, *Kildare Terrace, Bayswater, London* ann.
1892 Galton, F., F.R.S., 42, *Rutland Gate, S.W.* ann.
1885 Gaskell, W. H., F.R.S., *The Uplands, Shelford, Cambridge* C.
1885 Gaskell, E. H. C.
1899 Gardiner, Dr. Edw. G., *Woods Hole, Mass., U.S.A.* C.
1893 Gatty, Charles Henry, LL.D., F.L.S., *Felbridge Place, East Grinstead* ... C.
1897 Gibbs, Hon. Henry, 10, *Lennox Gardens, S.W.* ann.
1884 Gibson, Ernest, F.Z.S., c/o Fraser, Stoddart, and Ballingall, 16, *Castle Street, Edinburgh* ann.
1885 Gordon, Rev. J. M., *St. John's Vicarage, Redhill, Surrey* ann.
1885 Gotch, Prof. F., F.R.S., *University Museum, Oxford* ann.
1884 Grove, E., *Norlington, Preston, Brighton* ann.
1884 Groves, J. W., *Wargrave Lodge, Wargrave-on-Thames* ann.
1900 Groves, C.E., F.R.S., *Guy's Hospital, London, S.E.* ann.
1899 Guinness, Hon. Rupert, *Elveden, Thetford* C
†1884 Günther, Dr. Albert, F.R.S., 2, *Lichfield Road, Kew Gardens* ann.
1900 Gurney, E., 28, *Grosvenor Place, S.W.* ann.

1884 Haddon, Prof. Alfred C., M.A., F.R.S., *Innisfail, Hills Road, Cambridge* ann.
1884 Halliburton, Prof. W. D., M.D., F.R.S., *Church Cottage*, 17, *Marylebone Road, London, W.* ann.
1884 Hannah, Robert, 82, *Addison Road, Kensington, W.* C.
1897 Hargreaves, P., *The Fishery, North Hayling, Hants.* ann.
*1885 Harmer, S. F., D.Sc., F.R.S., *King's College, Cambridge* C.
1889 Harvey, T. H., *Cattedown, Plymouth* ann.
1888 Haselwood, J. E., 3, *Lennox Place, Brighton* C.
1884 Haslam, Miss E. Rosa, *Ravenswood, Bolton* £20
1884 Hayne, The Rt. Hon. C. Seale, M.P., 6, *Upper Belgrave Street, S.W.* ... ann.
1884 Head, J. Merrick, F.R.G.S., J.P., *Ardverness, Reigate* ann.
1884 Heape, Walter, *Heyroun, Chaucer Road, Cambridge* C.
*1884 Herdman, Prof. W. A., F.R.S., *University College, Liverpool* ann.
1884 Herschel, J., Col., R.E., F.R.S., *Observatory House, Slough, Berks.* C.
1884 Heywood, James, F.R.S. C.
1889 Heywood, Mrs. E. S., *Light Oaks, Manchester* C.
1884 Hickson, Prof. Sydney J., M.A., D.Sc., F.R.S., *Ellesmere House, Wilenslow Road, Withington, Manchester* ann.
1897 Hodgson, T. V., c/o L. E. Sexton, Esq., 17, *Collinge Park, Higher Compton, Plymouth* ann.
1884 Holdsworth, E. W. H., F.L.S., F.Z.S., *Lucerne House, Dartmouth* ann.
1893 Holt, Mrs. Vesey W., 104, *Elm Park Gardens, S.W.* ann.
*1887 Howes, Prof. G. Bond, F.R.S., F.L.S., *Science and Art Department, South Kensington* ann.
1884 Hudleston, W. H., M.A., F.R.S., 8, *Stanhope Gardens, South Kensington, S.W.* ann.

1891	Indian Museum, *Calcutta*	*ann.*
1888	Inskip, Capt. G. H., R.N., 22, *Torrington Place, Plymouth*	*ann.*

1885	Jackson, W. Hatchett, M.A., F.L.S., *Pen Wartha, Weston-super-Mare*	*ann.*
1893	Jago, Edward, *Coldrenick, Liskeard, Cornwall*	*ann.*
1887	Jago-Trelawny, Major-Gen., F.R.G.S., *Coldrenick, Liskeard*	*C.*
1890	Johnson, Prof. T., D.Sc., F.L.S., *Royal College of Science, Dublin*	*ann.*
1894	Justen, F. W., F.G.S., F.Z.S., 120, *Alexandra Road, South Hampstead, London, N.W.*	*ann.*

1884	Kellock, W. B., F.L.S., F.R.C.S., 94, *Stamford Hill, N.*	*ann.*
1899	Kent, W. Saville, F.L.S., *The Elms, Elmswood Rd., Croydon*	*ann.*

1897	Lanchester, W. F., B.A., "*Shirley,*" *Croydon, Surrey*	*C.*
1885	Langley, J. N., F.R.S., *Trinity College, Cambridge*	*C.*
*1895	Lister, J. J., M.A., F.R.S., *St. John's College, Cambridge*	*ann.*
1888	Lopes, The Rt. Hon. Sir Massey, Bart., *Maristow, Roborough, South Devon*	*ann.*

1885	Macalister, Prof. A., F.R.S., *St. John's College, Cambridge*	*ann.*
1900	Macfie, J. W. Scott, *Rowton Hall, Chester*	*C.*
1884	Mackrell, John, *High Trees, Clapham Common, S.W.*	*C.*
1886	MacMunn, Charles A., M.D., *Oak Leigh, Wolverhampton*	*ann.*
1889	Makovski, Stanislaus, *Fairlawn, Redhill*	*ann.*
1885	Marr, J. E., M.A., *St. John's College, Cambridge*	*C.*
1884	McAndrew, James J., *Lukesland, Ivybridge, South Devon*	*ann.*
1884	McIntosh, Prof. W. C., F.R.S., 2, *Abbotsford Crescent, St. Andrews, N.B.*	*C.*
1884	Michael, Albert D., *Cadogan Mansions, Sloane Square, S.W.*	*C.*
*1899	Minchin, Prof. E. A., *University College, London*	*ann.*
1885	Mocatta, F. H., 9, *Connaught Place, W.*	*C.*
1886	Mond, Ludwig, F.R.S., 20, *Avenue Road, Regent's Park, N.W.*	*C.*
1884	Morgan, Prof. C. Lloyd, F.R.S., *University College, Bristol*	*ann.*
1891	Morgans, Thomas, 60, *Queen Square, Bristol*	*ann.*
†1889	Morley, The Rt. Hon. the Earl of, 31, *Prince's Gardens, S.W.*	*ann.*
1885	Morrison, Alfred, 16, *Carlton House Terrace, London, W.*	£52 10*s.*
†1896	Murray, Sir John, K.C.B., F.R.S., *Challenger Lodge, Wardie, Edinburgh*	*ann.*

†1884	Newton, Prof. Alfred, M.A., F.R.S., *Magdalen College, Cambridge*	£20
†1884	Norman, Rev. Canon, M.A., D.C.L., F.R.S., *The Red House, Berkhamsted, Herts*	*ann.*

1884	Ommanney, Admiral Sir Erasmus, K.C.B., F.R.S., 29, *Connaught Square, W.*	*ann.*

1898	Parkinson, J., 251, *Camden Road, London, N.*	*ann.*
1884	Parsons, Chas. T., *Norfolk Road, Edgbaston, Birmingham*	*ann.*
1900	Peek, Sir Cuthbert, Bart., 22, *Belgrave Square, London, S.W.*	*ann.*
1885	Phillips, Chas. D. F., M.D., 10, *Henrietta Street, Cavendish Square, W.*	*C.*
1887	Phipson, Mrs., *Dasak Bungalow, Naisk Road, Bombay, India*	*ann.*
1886	Power, Henry, F.R.C.S., 37A, *Great Cumberland Place, W.*	*ann.*
1885	Pritchard, Prof. Urban, 26, *Wimpole Street, W.*	*ann.*
1884	Pye-Smith, P. H., M.D., 48, *Brook Street, W.*	*C.*

1897 Quentin, C., *Milland, Liphook, Hants.* .... ann.
1893 Quintin, St. W. H., *Scampstone Hall, Rillington, Yorks* .... ann.

1884 Ralli, Mrs. Stephen, 32, *Park Lane, W.* £30
1885 Ransom, W. B., *The Pavement, Nottingham* .... C.
1893 Rashleigh, E. W., *Kilmarth, Par Station, Cornwall* .... ann.
1888 Rawlings, Edward, *Richmond House, Wimbledon Common* .... ann.
1892 Robinson, Miss M., *University College, London, W.C.* .... ann.
1892 Rüffer, M.A., M.D., *Conseil Sanitaire, Maritime et Quarentenaire, Alexandria, Egypt* .... ann.

1897 Sandeman, H. D., 4, *Elliot Terrace, Plymouth* .... ann.
1888 Scharff, Robert F., Ph.D., *Science and Art Museum, Dublin* .... ann.
1884 Sclater, P. L., F.R.S., Sec. Zool. Soc., 3, *Hanover Square, W.* .... ann.
1884 Sclater, W. L., *The Museum, Cape Town* .... ann.
*1885 Scott, D. H., M.A., Ph.D., F.R.S., *Old Palace, Richmond, Surrey* .... C.
1884 Sedgwick, A., M.A., F.R.S., *Trinity College, Cambridge* .... C.
1888 Serpell, E. W., 19, *Hill Park Crescent, Plymouth* £50
1900 Sexton, L. E., 17, *Collinge Park, Higher Compton, Plymouth* .... ann.
1898 Seyd, Ernest, 38, *Lombard Street, London, E.C.* .... ann.
1885 Sheldon, Miss Lilian, *The Murmurs, Exmouth* .... ann.
1884 Shipley, Arthur E., M.A., *Christ's College, Cambridge* .... C.
1886 Shore, T. W., M.D., *Heathfield, Allegn Park, Dulwich, London, S.E.* ... ann.
1894 Simpson, F. C., J.P., *Maypool, Churston Ferrers, R.S.O.* .... ann.
1885 Sinclair, F. G., *Friday Hill, Chingford, Essex* .... C.
1891 Sinclair, William F., 102, *Cheyne Walk, Chelsea, S.W.* .... C.
1884 Skinners, the Worshipful Company of, *Skinners' Hall, E.C.* £42
1889 Slade, Commander E. J. Warre, *Milton Heath, Dorking* .... C.
1893 Sorby, H. C., LL.D., F.R.S., *Broomfield, Sheffield* .... ann.
1888 Spencer, Prof. W. Baldwin, M.A., *University of Victoria, Melbourne* ... ann.
1884 Spring-Rice, S. E., C.B., 1, *Bryanston Place, Bryanston Square, W.* ... C.
*1884 Stewart, Prof. Chas., F.R.S., *Royal College of Surgeons, Lincoln's Inn Fields, W.C.* .... ann.
1897 Straker, J., L.L.M., F.Z.S., *Oxford and Cambridge Club, S.W.* .... C.
1884 Sutherland, The Duke of, *Stafford House, St. James', S.W.* .... C.

1894 Thomas, W. F., *Bishopshalt, Hillingdon, Middlesex* .... ann.
*1899 Thompson, Prof. D'Arcy W., C.B., *University College, Dundee* .... ann.
1890 Thompson, H. F., B.A., 35, *Wimpole Street, W.* .... ann.
1884 Thornycroft, John I., *Eyot Villa, Chiswick Mall* .... ann.
1888 Thurston, Edgar, *Government Central Museum, Egmore, Madras* .... ann.
1899 Tims, H. W. Marett, M.D., F.L.S., 19, *Lyndewode Road, Cambridge* ... ann.
*1897 Travers, J. A., *Dorney House, Weybridge* .... ann.
1888 Tripe, Major-General, 3, *Osborne Villas, Stoke, Devonport* .... ann.

1888 Vallentin, Rupert, 1, *Melville Road, Falmouth* .... ann.
1891 Vaughan, Henry, 28, *Cumberland Terrace, N.W.* .... ann.
1884 Venning, Mrs., 3, *Wingfield Villas, Stoke, Devonport* £50
1884 Vines, Professor Sydney H., M.A., D.Sc., F.R.S., *Botanical Gardens, Oxford* .... ann.

1884	Walker, Alfred O., *Uleombe Place, Maidstone*	*ann.*
1884	Walker, P. F., 36, *Prince's Gardens, S.W.*	*ann.*
†1884	Walsingham, Lord, F.R.S., *Merton Hall, Thetford*	£20
1890	Waterhouse, Edwin, *Feldmore, near Dorking*	*ann.*
1891	Wildy, A. G., 14, *Buckingham Street, Adelphi, London, W.C.*	*ann.*
1900	Willey, A., D.Sc., *Guy's Hospital, London, E.C.*	*ann.*
1884	Wilson, Scott B., *Heather Bank, Weybridge Heath*	*C.*
1900	Wolfenden, R. N., M.D., *Rougemont, Seaford, Sussex*	*ann.*
1884	Woodall, John W., M.A., F.G.S., 5, *Queen's Mansions, Victoria Street, London, S.W.*	*ann.*
1898	Worth, R. H., 42, *George Street, Plymouth*	*ann.*

IV.—Associate Members.

1889 Alward, George, 11, *Hainton Street, Great Grimsby.*
1900 Bignell, G. C., F.E.S., *The Fens, Home Park Road, Saltash, Cornwall.*
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1889 Dannevig, Capt. G. M., *Arendal, Norway.*
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1889 Ridge, B. J., *Newlyn, Penzance.*
1890 Roach, W., 4, *Gascoyne Place, Plymouth.*
1889 Shrubsole, W. H., 62, *High Street, Sheerness-on-Sea.*
1889 Sinel, Joseph, 2, *Peel Villas, Cleveland Road, Jersey.*
1890 Spencer, R. L., *L. and N.W. Depôt, Guernsey.*
1890 Wells, W., *The Aquarium, Brighton.*
1890 Wiseman, Fred., *Buckland House, Paglesham, Rochford, Essex.*

Marine Biological Association of the United Kingdom.

PRICE LIST OF MARINE SPECIMENS.

THE following list contains a selection of the more common forms of marine animals and plants which occur in the neighbourhood of Plymouth, and are suitable for laboratory work and for museums.

Preserved specimens are usually in stock, and can then be forwarded immediately on receipt of order; the prices quoted are for such specimens. Living specimens will generally be charged at the same rate as preserved specimens, but when delivery is required on a particular day an extra charge may be made, according to the additional labour involved.

All orders are attended to as promptly as possible; but when fresh specimens are required a delay is often unavoidable, owing to uncertainty of weather, or to scarcity of animals at the particular season.

It should be stated, in ordering, whether the specimens are required for museums, dissection, or histological work. The prices include spirit in the case of preserved specimens, and glass tubes for all small ones. Hampers, barrels, packing-cases, bottles, jars and tins will be charged for. Hampers and barrels may be returned, and will be allowed for in full, if not damaged. Small parcels are forwarded by Parcel Post; large packages by goods train in the case of preserved specimens, by passenger train for living ones.

Special attention will be paid to orders for rare animals and plants, and stages in their development.

The list of Algæ contains specimens most suitable for laboratory work, preserved to show their various reproductive stages and other special features.

A list of papers dealing with special groups, and supplying the information on the fauna and flora hitherto published by the Association, is given below.

Cheques should be made payable to the Marine Biological Association, and all communications addressed to THE DIRECTOR, THE LABORATORY, CITADEL HILL, PLYMOUTH.

October, 1900.

PAPERS ON THE FAUNA AND FLORA OF PLYMOUTH.

Published in the Journal of the Association.

"Preliminary Report upon the Fauna and Flora of Plymouth Sound," by Walter Heape . .	O.S. Vol. i. pp. 153–193.
"Director's Report," by G. C. Bourne . .	N.S. Vol. i. p. 5.
"Notes on the Marine Oligochæta of Plymouth," by F. E. Beddard	N.S. Vol. i. p. 69.
"Report on the Pelagic Copepoda collected at Plymouth in 1888–89," by G. C. Bourne .	N.S. Vol. i. p. 144.
"Report on the Nudibranchiate Mollusca of Plymouth Sound," by W. Garstang . .	N.S. Vol. i. p. 173.
"Flora of Plymouth Sound and Adjacent Waters," Preliminary Paper, by Prof. T. Johnson .	N.S. Vol. i. p. 286.
"Notes on the Hydroids of Plymouth," by G. C. Bourne	N.S. Vol. i. p. 391.
"A Complete List of the Opisthobranchiate Mollusca found at Plymouth," by W. Garstang . .	N.S. Vol. i. p. 399.
"Report on the Tunicata of Plymouth," by W. Garstang	N.S. Vol. ii. p. 47.
"Notes on the Marine Invertebrate Fauna of Plymouth for 1892," by W. Garstang . .	N.S. Vol. ii. p. 333.
"Notes on the Plankton observed at Plymouth during June–September, 1892," by E. J. Bles	N.S. Vol. ii. p. 340.
"List of Nemertines of Plymouth Sound," by T. H. Riches	N.S. Vol. iii. p. 1.
"The Turbellaria of Plymouth Sound and its Neighbourhood," by F. W. Gamble . .	N.S. Vol. iii. p. 30.
"Faunistic Notes at Plymouth during 1893–4," by W. Garstang	N.S. Vol. iii. p. 212.
"Faunistic Notes," by E. J. Allen . . .	N.S. Vol. iv. p. 48.
"Notes on Plymouth Hydroids," by Prof. C. C. Nutting	N.S. Vol. iv. p. 146.
"A List of the Parasitic Copepoda of Fish obtained at Plymouth," by Staff-Surgeon P. W. Basset-Smith, R.N. . . .	N.S. Vol. iv. p. 155.
"Notes on Dredging and Trawling Work during the latter half of 1895," by E. J. Allen .	N.S. Vol. iv. p. 164.
"On *Doris maculata*, a new species of Nudibranchiate Mollusc found at Plymouth," by W. Garstang	N.S. Vol. iv. p. 167.
"On the changes in the Pelagic Fauna of Plymouth during September, 1893 and 1895," by E. T. Browne	N.S. Vol. iv. p. 168.
"Notes on the Pelagic Fauna at Plymouth, August to December, 1895," by T. V. Hodgson .	N.S. Vol. iv. p. 173.
"Algological Notes," by G. Brebner . . .	N.S. Vol. iv. pp. 179 & 286.
"Notes on New or Rare British Marine Polyzoa," by S. F. Harmer	N.S. Vol. v. p. 51.
"On the Pelagic Fauna of Plymouth for September, 1897," by E. T. Browne . . .	N.S. Vol. v. p. 186.
"On the Fauna and Bottom Deposits near the thirty-fathom line from the Eddystone Grounds to Start Point," by E. J. Allen . . .	N.S. Vol. v. p. 365.

PRICE LIST OF MARINE SPECIMENS.

PROTOZOA.

FORAMINIFERA		s.	d.
Polystomella	per tube*	1	6
Haliphysema	,,	2	6
Various other species	,,	2	0
HELIOZOA			
Actinosphærium	,,	1	0
RADIOLARIA			
Acanthometra	,,	2	0
INFUSORIA			
Ceratium	,,	1	6
Peridinium	,,	1	6
Noctiluca miliaris	,,	1	0
Zoothamnium	,,	1	0

PORIFERA.

Terminology is that of R. Hanitsch, "Revision of Generic Nomenclature and Classification in Bowerbank's *British Spongiadæ*." *Trans. Liverpool Biol. Soc.*, vol. 8, 1894.

		s.	d.
Leucosolenia botryoides	each	2	0
Sycon compressum	per doz.	2	0
coronatum	,,	2	6
Oscarella lobularis	each	1	0
Spongelia fragilis	,,	3	6
Halichondria panicea	,,	2	0
Reniera sp.	,,	2	6
Chalina oculata	,,	3	0
Desmacidon fruticosum	,,	2/6 to 7/6	
Raspailia hispida	,,	3	0
Hymeniacidon sanguineum	per crust	2	0
Suberites domuncula	each	1	6
Cliona celata	,,	2	0
Polymastia mammillaris	,,	2	6
Pachymatisma Johnstonia	,,	2	6
Tethya lyncurium	,,	2	6

HYDROZOA.

Terminology is that of Hincks' *British Marine Hydroids.*

GYMNOBLASTEA		s.	d.
Clava squamata	per tube	1	6
Tubiclava lucerna	,,	3	6
cornucopiæ	,,	2	6
Hydractinia echinata	,,	2	0
Podocoryne carnea	,,	2	0
Lar sabellarum	,,	3	0
Coryne vaginata	,,	1	6
Syncoryne eximia	,,	1	6
Sarsii	,,	1	6
Myriothela phrygia	each	0	6
Eudendrium ramosum	per tube	1	6
capillare	,,	1	6
album	,,	1	6
Perigonimus repens	,,	1	6
Garveia nutans	,,	1	6
Heterocordyle Conybeari	,,	1	6
Bougainvillia ramosa	,,	2	0
Tubularia indivisa	,,	1	6
larynx	,,	1	6
humilis	,,	2	0
bellis	,,	2	0
crocea	,,	1	6
CALYPTOBLASTEA			
Clytia Johnstoni	,,	1	6
Obelia geniculata	,,	1	6
gelatinosa	,,	1	6
dichotoma	,,	1	6
Campanularia flexuosa	,,	1	6
Hincksii	,,	1	6
verticillata	,,	1	6
Gonothyræa Loveni	,,	1	6
Lafoëa dumosa	,,	1	6
Coppinia arcta	per tube	1	6
Calycella syringa	,,	1	6
Halecium halecinum	,,	1	6
Beanii	,,	1	6

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* The prices quoted are for ordinary preserved specimens. Living specimens, when obtainable, are generally charged at the same prices; museum specimens at a slightly increased rate.

		s.	*d.*
Sertularella polyzonias	per tube	1	6
Gayi .	,,	1	6
Diphasia rosacea .	,,	2	0
pinaster .	,,	2	0
Sertularia pumila .	,,	1	6
abietina .	,,	1	6
argentea .	,,	2	6
cupressina	,,	2	6
Hydrallmania falcata	,,	2	0
Thuiaria articulata .	,,	2	0
Antennularia antennina	,,	2	0
ramosa	,,	2	6
Aglaophenia pluma .	,,	1	6
tubulifera	,,	2	0
myriophyllum		2	0
Plumularia pinnata .	,,	1	6
setacea .	,,	1	6
Catharina	,,	1	6
similis .	,,	1	6

MEDUSAE

Terminology that of E. Haeckel, *System der Medusen;* and E. T. Browne, "British Hydroids and Medusæ." *Proc. Zool. Soc.*, 1896. Names of the latter author are in italics.

		s.	*d.*
Sarsia tubulifera .	per doz.	3	0
Codonium pulchellum	each	0	6
Perigonimus repens .	,,	0	6
Podocoryne carnea .	,,	0	6
Corymorpha nutans .	,,	0	3
Hybocodon prolifer .	,,	0	4
Lar sabellarum .	,,	0	6
Dipurena halterata .	,,	0	6
Amphinema dinema .	,,	0	6
Tiara pileata . .	,,	0	6
Lizzia blondina .	,,	0	4
Margelis principis .	,,	0	4
ramosa .	,,	0	4
Margellium octopunctatum	per doz.	3	0
Obelia gelatinosa .	,,	1	0
geniculata .	,,	1	0
lucifera .	,,	1	0
Tiaropsis diademata .	each	0	4
Euchilota pilosella .	,,	0	6
Phialidium Buskianum	per doz.	2	0
temporarium	,,	2	0
cymbaloideum	,,	2	0
Saphenia mirabilis .	each	0	6
Irene pellucida .	,,	0	6
Liriantha appendiculata	,,	0	6
Chrysaora isosceles .	,,	1	6
Cyanea Lamarckii .	,,	1	6
Aurelia aurita . .	,,	0	9
Ephyræ	per doz.	2	0

		s.	*d.*
Depastrum cyathiforme	each	1	0
Haliclystus octoradiatus	per doz.	3	0

SIPHONOPHORA

		s.	*d.*
Muggiæa atlantica (Cunningham) .	per doz.	1	6

CTENOPHORA.

		s.	*d.*
Pleurobrachia pileus	per doz.	3	6

ACTINOZOA.

HEXACTINIÆ

Terminology that of P. H. Gosse, *British Sea Anemones.*

		s.	*d.*
Actinoloba dianthus	each	2	6
Sagartia bellis .	,,	2	0
miniata .	,,	2	6
viduata .	,,	2	6
parasitica .	,,	1	6
Adamsia palliata .	,,	1	6
Anthea cereus .	,,	1	0
Actinia mesembryanthemum		6*d.* to	1/-
Bunodes gemmacea .	each	1	0
Tealia crassicornis .	,,	6*d.* to	1/-
Halcampa chrysanthellum	,,	2	0
Arachnactis sp. .	,,	1	0
Corynactis viridis .	,,	1	0
Gephyra Dohrnii .	,,	2	0
Zoanthus Couchii .	,,	1	6
Caryophyllia Smithii	,,	1	6

Living specimens of Hexactiniæ may be had at one-half the above prices.

OCTACTINIÆ

		s.	*d.*
Alcyonium digitatum	per col.	2	0
Eunicella (Gorgonia) verrucosa .	,,	2	6
Sarcodictyon catenata	,,	2	6

ECHINODERMA.

Terminology is that of Prof. F. Jeffrey Bell, *Catalogue of British Echinoderms*, British Museum.

		s.	*d.*
Cucumaria pentactes	each	1	0
lactea .	per doz.	2	6
planci .	each	1	6
Thyone fusus .	,,	1	6
Holothuria nigra .	each	1	6
Synapta inhaerens .	,,	1	0
Antedon rosacea .	per doz.	4	6
Pentacrinoid larvæ	per tube	2	0
Astropecten irregularis	each	0	9
Luidia Sarsi . .	,,	2	6

		s.	d.
Porania pulvillus	each	1	6
Asterina gibbosa	per doz.	2	0
Palmipes placenta	each	1	6
Solaster papposus	,,	1	0
Henricia sanguinolenta	,,	1	6
Asterias glacialis	per doz.	6	0
rubens	,,	6	0
Ophiura ciliaris	,,	4	6
Amphiura elegans	,,	1	6
Ophiactis Balli	,,	2	6
Ophiocoma nigra	,,	4	6
Ophiothrix fragilis	,,	4	0
Ophiocnida brachiata	each	0	6
Echinus acutus	,,	2	0
miliaris	,,	0	9
esculentus	,,	0	9
Echinocyamus pusillus	,,	1	0
Spatangus purpureus	,,	1	0
Echinocardium cordatum	,,	1	0
pennatifidum	,,	2	6
Segmenting ova and larvæ—Plutei, Bipinnariæ and Auriculariæ	per doz.	2	0

TURBELLARIA.

Terminology that of F. W. Gamble, *Turbellaria of Plymouth Sound and Neighbourhood.* (*Jour. M. B. A.* vol. iii. p. 30.)

Convoluta paradoxa	per doz.	3	6
Plagiostoma vittatum	,,	2	0
Enterostoma Austriacum	each	0	4
Cylindrostoma quadrioculatum	per doz.	2	6
Stylochoplana maculata	,,	4	0
Leptoplana tremellaris	,,	3	0
Prostheceræus vittatus	each	0	6
Cycloporus papillosus	,,	0	4
Eurylepta cornuta	,,	0	6
Oligocladus sanguinolentus	,,	0	4
Stylostomum variabile	,,	0	3

NEMERTINA.

Terminology that of T. H. Riches, *List of the Nemertines of Plymouth Sound.* (*Jour. M.B.A.* vol. iii. p. 1.)

		s.	d.
Carinella annulata (McIntoshii)	each	0	6
superba	,,	1	0
Cephalothrix linearis	,,	1	0
bioculata	per doz.	2	0
Amphiporus lactifloreus	,,	1	6
dissimulans	each	0	9
Drepanophorus spectabilis	,,	2	6
Tetrastemma flavidum	per doz.	2	6
dorsale	,,	1	6
candidum	,,	2	6
vermiculatum	per doz.	2	0
melanocephalum	per doz.	2	0
Nemertes gracilis	each	1	0
Neesii	,,	1	0
Eupolia curta	,,	2	0
Lineus marinus	,,	1	6
obscurus	per doz.	1	6
bilineatus	,,	3	0
Micrura purpurea	,,	2	6
fasciolata	,,	2	6

CHÆTOGNATHA.

Spadella bipunctata	per doz.	1	0

GEPHYREA.

Thalassema neptuni	each	1	0
Petalostoma minutum	per doz.	2	6
Phascolion strombi	each	1	6
Phascolosoma	,,	1	0
Phoronis hippocrepia	each	0	3

ARCHIANNELIDA.

Histriodrilus homari	per doz.	3	6
Polygordius sp.	each	1	0
Dinophilus tæniatus	per doz.	2	6

OLIGOCHÆTA.

Clitellio arenarius	per doz.	2	0
ater	,,	2	0

POLYCHÆTA.

Terminology generally that of de Saint-Joseph, *Les Annélides Polychètes des Côtes de Dinard.* Ann. Sci. Nat. 1887–1895.

Aphrodite aculeata	each	1	0
Hermione hystrix	,,	2	0
Halosydna gelatinosa	,,	0	4
Lepidonotus clava	per doz.	1	6
squamatus	,,	1	6
Sthenelais boa	each	0	9
Euphrosyne foliosa	,,	0	6
Hyalinœcia tubicola	,,	0	6

		s.	d.
Eunice Harrassii	each*	1	0
Marphysa sanguinea	,,	1	3
Lysidice Ninetta	,,	1	0
Maclovia iricolor	,,	1	0
Lumbriconereis Latreillii	,,	0	9
Ophryotrocha puerilis	per doz.	2	6
Nereis cultrifera	,,	2	0
pelagica	,,	2	6
fucata	each	0	6
diversicolor	per doz.	1	6
Dumerillii	each	0	6
irrorata	,,	0	6
longissima	,,	0	6
procera	,,	0	6
Nephthys cœca	,,	0	9
Hombergii	,,	0	9
longisetosa (Johnston)	each	0	9
Glycera capitata	,,	0	9
convoluta	,,	0	9
dubia (Johnston)	,,	1	0
Syllis prolifera	per doz.	3	0
armillaris	,,	3	0
Amblyosyllis (Gattiola) spectabilis	each	0	4
Autolytus prolifer (Müll)	,,	0	4
Myrianida maculata	,,	0	6
Phyllodoce lamelligera	,,	1	0
maculata	per doz.	1	6
Pancerina	each	1	0
Eulalia viridis	per doz.	3	6
Tomopteris onisciformis	each	1	6
Cirratulus tentaculatus	per doz.	6	0
cirratus	each	1	0
Notomastus latericeus	,,	1	0
Spio sp.	,,	0	4
Nerine vulgaris	,,	0	4
coniocephala	,,	0	4
Scoloplos armiger	,,	0	6
Arenicola marina	,,	0	6
ecaudata	,,	0	6
Grubii	,,	1	0
Clymene sp.	,,	1	0
Chætopterus variopedatus	,,	0	9
Siphonostoma affinis	,,	0	9
Trophonia plumosa	,,	1	0
Sabellaria alveolata	per doz.	2	6
Pectinaria auricoma	each	1	0
Amphitrite Johnstoni	,,	0	9
Terebella lapidaria	,,	0	6
Lanice conchilega	,,	0	9
Nicolea venustula	each	1	6
Thelepus cincinnatus	,,	1	0
Polycirrus aurantiacus	,,	0	6
Sabella pavonina	,,	0	6
Branchiomma vesiculosum	,,	0	6
Dasychone bombyx	,,	0	6
Bispira volutacornis	,,	1	6
Myxicola infundibulum	,,	1	0
Serpula vermicularis	,,	0	6
Hydroides norvegica	,,	0	2
Protula tubularia	,,	1	0
Filograna implexa	per tube	1	6
Spirorbis borealis	,,	1	0
Trochospheres and post-larval stages	per tube	2	0
Myzostomum glabrum	per doz.	1	0

HIRUDINEA.

		s.	d.
Pontobdella muricata	each	1	6

CRUSTACEA.

CLADOCERA

		s.	d.
Evadne Nordmanni	per tube	1	6
Podon intermedius	,,	1	6

OSTRACODA

		s.	d.
Cypris, Cythere, etc.	,,	1	6

COPEPODA

Terminology in general that of Giesbrecht, *Pelagische Copepoden* (Naples monograph), 1892, and *Das Thierreich*, 1898; supplemented by Brady, *British Copepoda*, 1878–80.

		s.	d.
Calanus finmarchicus	per tube	1	6
Pseudocalanus elongatus	,,	1	6
Paracalanus parvus	,,	1	6
Candace pectinata	,,	2	6
Temora longicornis	,,	1	6
Eurytemora affinis	,,	1	6
Centropages typicus	,,	1	6
Anomalocera Patersoni	,,	1	6
Acartia clausi	,,	1	6
bifilosa	,,	1	6
Oithona spinirostris	,,	1	6
Notodelphyidæ var sp.	,,	2	0
Corycaeus anglicus	,,	1	6
Monstrilla Danæ	each	1	0
Euterpe acutifrons	per tube	1	6

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		s.	*d.*
Dactylopus strömii .	per tube	1	6
Idya furcata .	,,	1	6
Longipedia coronata .	,,	1	6
Thalestris rufocincta.	,,	1	6
Harpacticus chelifer .	,,	1	6
Peltidium depressum	,,	1	6
Chondracanthus lophii	each	0	6
Nicothoë astaci .	per doz.	2	6
Caligus rapax . .	,,	2	6
Pandarus bicolor .	each	0	4
Anchorella triglæ .	,,	0	3
Numerous other species	each from	0	3

Cirripedia

Conchoderma auritum	each	0	6
Lepas anatifera .	,,	0	3
Scalpellum vulgare .	,,	0	3
Pyrgoma anglicum .	per col.	1	0
Balanus tintinnabulum	,,	0	6
amphitrite .	,,	0	6
crenatus .	,,	0	6
Chthamalus stellatus	,,	0	6

Rhizocephala

Sacculina carcini .	each	0	6

Leptostraca

Nebalia bipes .	per doz.	1	0

Amphipoda

Terminology that of G O. Sars. *Crustacea of Norway*, vol. i.

Hyperia galba .	each	0	3
Talitrus locusta .	per doz.	1	6
Orchestia littorea .	,,	1	6
Orchomene Batei .	each	0	2
Ampelisca lævigata .	per doz.	2	0
Leucothoë spinicarpa	,,	2	0
Paratylus Swammerdami	,,	2	6
Dexamine spinosa .	,,	2	6
Gammarus marinus .	,,	0	3
locusta .	,,	1	6
Melita obtusata .	,,	2	0
Amphithoë rubricata	,,	2	0
Podocerus falcatus .	,,	1	6
Ericthonius abditus .	,,	2	0
Corophium crassicorne	,,	2	0
Bonelli .	,,	1	6
Chelura terebrans .	,,	1	0
Phtisica marina .	,,	2	6
Protella phasma .	,,	1	0
Caprella linearis .	,,	2	0
æquilibra .	,,	2	0
acanthifera .	,,	2	0
tuberculata .	,,	2	0

Isopoda

Terminology that of V. Carus, *Prodromus Faunæ Mediterraneæ.*

		s.	*d.*
Apseudes talpa .	each	0	3
Latreillii .	,,	0	3
Anceus maxillaris .	per doz.	1	6
Conilera cylindracea .	each	0	3
Sphaeroma serratum .	,,	0	3
Idotea tricuspidata .	per doz.	1	6
linearis .	,,	2	6
emarginata .	,,	1	6
Jæra albifrons .	each	0	3
Munna Kroyeri (Goodsir)	,,	0	3
Janira maculosa (Leach)	,,	0	3
Arcturus intermedius (Goodsir)		0	3
Limnoria lignorum .	per doz.	2	6
Bopyrus squillarum .	each	1	0
Cryptophthiria balani	,,	0	4
Microniscus sp. .	per doz.	3	6
Ligia oceanica . .	,,	1	6

Cumacea

Iphinoe trispinosa .	per doz.	2	6
Pseudocuma longicornis	,,	2	6
Diastylis Rathkii .	,,	2	6

Mysidæ

Terminology that of Canon Norman, "On British Mysidæ." *Ann. Mag.* N.H. 1892.

Siriella armata .	per doz.	1	6
Gastrosaccus sanctus.	,,	2	0
Anchialus agilis .	,,	2	0
Leptomysis mediterranea	,,	2	0
Macropsis Slabberi .	,,	2	0
Schistomysis spiritus	,,	1	6
Parkeri.	,,	2	6
arenosa.	,,	1	6
Macromysis flexuosa .	,,	1	6
Neomysis vulgaris .	,,	1	6

Decapoda

Terminology that of V. Carus, *Prodromus Faunæ Mediterraneæ.*

Palæmon serratus .	per doz.	4	0
squilla .	,,	5	0
Palæmonetes varians	,,	1	6
Pandalus annulicornis (Leach)	per doz.	1	6
brevirostris	,,	3	0
Virbius varians .	,,	2	6
Crangon vulgaris .	,,	1	0
trispinosus .	,,	2	0
Nephrops norvegicus	each	1	6

		s.	d.
Homarus vulgaris	each*	2/6 to 5/–	
Palinurus vulgaris	each	2/6 to 7/6	
Galathea squamifera	per doz.	3	6
dispersa	,,	3	6
strigosa	each	1	0
Eupagurus Bernhardus	,,	0	6
Prideauxii	,,	0	6
cuanensis	,,	0	6
lævis	,,	0	3
Diogenes varians	,,	0	4
Porcellana platycheles	per doz.	2	6
longicornis	,,	1	6
Ebalia Bryeri	each	1	0
Cranchii	,,	1	0
Pennantii	,,	1	0
Stenorhyncus phalangium	,,	0	6
ægyptius	,,	1	6
longirostris	,,	0	6
Achaeus Cranchii	,,	0	6
Inachus scorpio	,,	0	6
dorynchus	,,	1	0
Maia squinado	,,	3	6
Pisa Gibbsii	,,	1	6
tetraodon	,,	1	6
Hyas araneus	,,	2	0
coarctatus	,,	1	6
Eurynome aspera	,,	0	4
Cancer pagurus	,,	1/– to 5/–	
Pirimela denticulata	,,	1	6
Xantho rivulosa	,,	0	6
florida	,,	0	6
Pilumnus hirtellus	,,	0	6
Portunus puber	,,	0	4
depurator	,,	0	4
pusillus	,,	0	4
arcuatus	,,	1	0
marmoreus	,,	0	6
corrugatus	,,	1	0
Polybius Henslowii	,,	1	0
Carcinus mænas	,,	0	4
Atelecyclus heterodon	,,	0	6
Corystes cassivelaunus	,,	0	6
Pinnotheres pisum	,,	2	0
Gonoplax rhomboides	,,	2	6
Zoææ and other larval stages	per tube	2	0

PYCNOGONIDA

Terminology that of Hoek, *Nouvelles études sur les Pycnogonides*, Archiv. zool. expér. et gen. ix. 1881.

		s.	d.
Nymphon gracile	per doz.	2	0
gallicum	,,	2	0
Ammothea echinata	per doz.	2	6
Phoxichilidium femoratum	,,	2	6
Phoxichilus spinosus	,,	2	0
Pycnogonum littorale	,,	2	6

POLYZOA.

Terminology that of T. Hincks' *British Marine Polyzoa.*

		s.	d.
Scrupocellaria scruposa	per tube	1	6
elliptica	,,	1	6
Bicellaria ciliata	,,	1	6
Bugula turbinata	,,	1	6
flabellata	,,	1	0
Cellaria fistulosa	,,	1	0
sinuosa	,,	1	0
Flustra foliacea	,,	2	0
Membranipora pilosa	,,	1	0
membranacea		1	0
Membraniporella nitida	per tube	1	6
Microporella Malusii	,,	1	6
Schizoporella linearis	,,	1	0
Hippothoa divaricata	,,	1	6
Lepralia foliacea	,,	1	6
Smittia trispinosa	,,	1	0
Mucronella Peachii	,,	1	0
ventricosa	,,	1	0
Cellepora avicularis	,,	1	6
pumicosa	,,	1	6
ramulosa	,,	1	6
Crisia eburnea	,,	1	0
Stomatopora major	,,	1	6
Tubulipora flabellaris	,,	1	0
Idmonea serpens	,,	1	0
Diastopora patina	,,	1	0
Lichenopora hispida	,,	1	0
Alcyonidium gelatinosum	,,	1	0
Flustrella hispida	,,	1	0
Amathia lendigera	,,	1	0
Bowerbankia imbricata	,,	1	0
Cylindrœcium dilatatum	,,	1	0
Valkeria uva	,,	2	0
Pedicellina cernua	,,	1	0
Loxosoma phascolosomatum	,,	1	6

MOLLUSCA.

Terminology that of Forbes and Hanley, *British Mollusca.*

AMPHINEURA

		s.	d.
Chiton marginatus	per doz.	2	6
fascicularis	each	0	6
asellus	per doz.	3	0

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		s.	d.
Proneomenia aglaopheniae (Kowalevsky) .	each	2	0
Dondersia Banyulensis (Pruvot) . .	,,	2	0

Gastropoda

		s.	d.
Patella vulgata .	per doz.	2	0
pellucida .	,,	2	6
Acmæa virginea .	,,	3	6
Emarginula reticulata	each	0	6
Fissurella græca .	,,	0	6
Trochus zizyphinus .	per doz.	1	0
granulatus .	each	0	6
cinerarius .	per doz.	1	0
umbilicatus .	,,	1	0
magus .	each	0	6
Phasianella pullus .	per doz.	2	6
Littorina littorea .	,,	1	0
littoralis .	,,	1	0
Rissoa parva . .	,,	2	0
Capulus hungaricus .	each	0	3
Calyptræa sinensis .	,,	0	3
Cypraea europea .	,,	0	3
Natica nitida . .	,,	0	6
Lamellaria perspicua	,,	0	6
Aporrhais pes-pelicani	,,	0	6
Scalaria communis .	,,	0	6
Turritella terebra .	per doz.	3	0
Buccinum undatum .	each	0	9
for dissection	,,	0	6
Nassa reticulata .	per doz.	2	0
incrassata .	,,	2	0
Murex erinaceus .	,,	2	0
Purpura lapillus .	,,	1	0
Otina otis . .	,,	4	0
Scaphander lignarius	each	0	6
Haminea hydatis .	,,	1	0
Philine aperta .	,,	0	3
punctata .	,,	0	6
Runcina coronata (Quatrefages)		0	6
Aplysia punctata .	each	0	9
Oscanius membranaceus (Montagu)	each	0	4
Pleurobranchus plumula	,,	0	6

Terminology that of R. Bergh, *System der Nudibranchiaten Gasteropoden.*

		s.	d.
Tritonia Hombergii .	each	2	6
Candiella (Tritonia) plebeia	,,	0	3
Dendronotus arborescens	,,	1	0
Lomanotus genei .	,,	1	0
Triopa claviger .	,,	0	6
Polycera quadrilineata	,,	0	3
Ægirus punctilucens	,,	0	6
Ancula cristata .	,,	0	6
Goniodoris nodosa .	per doz.	3	0
castanea .	each	0	6
Archidoris tuberculata	,,	1	0
flammea .	,,	1	0
Jorunna Johnstoni .	,,	0	6
Platydoris planata .	,,	0	6
Rostanga coccinea .	,,	0	6
Doris maculata (Garstang)	,,	1	6
Acanthodoris pilosa .	,,	0	6
Lamellidoris aspera .	,,	0	6
bilamellata	,,	0	6
Æolis papillosa .	,,	1	0
Hero formosa . .	,,	0	6
Æolidiella Alderi .	,,	0	6
glauca .	,,	0	6
Cratena viridis .	,,	0	6
olivacea .	,,	0	6
amæna .	,,	0	6
Galvina tricolor .	,,	0	6
Coryphella rufibranchialis	,,	0	6
Landsburgii	,,	0	6
smaragdina	,,	0	6
Facelina coronata .	,,	0	6
Antiopa cristata .	,,	0	6
Doto fragilis . .	,,	0	6
coronata . .	,,	0	6
Elysia viridis . .	,,	0	6
Limapontia capitata .	,,	1	0
nigra .	,,	0	6

Terminology that of Forbes and Hanley, *British Mollusca.*

Scaphopoda

		s.	d.
Dentalium entalis .	each	1	0

Lamellibranchia

		s.	d.
Nucula nucleus .	,,	0	9
Anomia ephippium .	per doz.	2	6
Pectunculus glycimeris	,,	3	0
Arca tetragona .	each	1	0
lactea . .	,,	1	0
Mytilus edulis . .	per doz.	1	6
Pinna pectinata .	each	1	6
Ostrea edulis . .	,,	0	6
Pecten maximus .	,,	0	6
tigrinus .	,,	0	6
opercularis .	per doz.	2	6
Lima Loscombii .	each	0	6
Cyprina islandica .	,,	2	0
Kellia suborbicularis	,,	0	6
Scrobicularia piperata	,,	0	6
Mactra solida . .	,,	0	4
Venus fasciata . .	,,	0	6
striatula .	,,	0	6
ovata . .	,,	0	6

		s.	d.
Artemis exoleta .	each*	0	8
Astarte sulcata .	,,	0	8
Lucina borealis .	,,	1	0
flexuosa .	,,	1	0
Tapes pullastra .	per doz.	2	6
virginea .	each	0	6
Cardium edule .	per doz.	2	0
echinatum .	each	0	9
norvegicum	per doz.	6	0
Tellina crassa . .	each	0	9
Psammobia ferroensis	,,	1	0
telinella .	per doz.	5	0
Lutraria elliptica .	each	2	0
Montacuta substriata	,,	0	3
ferruginosa	,,	0	3
Crenella marmorata .	,,	0	3
Solen marginatus .	,,	0	9
ensis . .	per doz.	4	0
Saxicava rugosa .	,,	1	6
Pholas parva . .	each	1	0
dactylus .	,,	1	0
Pholadidea papyracea	,,	1	0
Teredo norvegica .	,,	1	6
Lyonsia norvegica .	,,	2	0
Pandora obtusa .	,,	1	0
Veligers, and other larval stages	per tube	2	0

CEPHALOPODA

		s.	d.
Ommastrephes sagittatus	each	3	6
Sepiola atlantica .	per doz.	3	6
Loligo Forbesii .	each	1/- to 2/6	
media . .	,,	1	6
Sepia officinalis .	,,	1	0
elegans . .	,,	1	6
Octopus vulgaris .	,,	2	6
Eledone cirrhosus .	,,	1	0
Rossia Oweni . .	,,	3	0

TUNICATA.

Terminology in general that of Herdman, *Revised Classification of the Tunicata.* Jnl. Linn. Soc. vol. xxiii. 1891.

		s.	d.
Oikopleura dioica .	per doz.	2	6
Thalia (Salpa) democratica-mucronata . .	,,	2	0
Thalia (Salpa) containing embryos . .	,,	3	6
Thalia (Salpa) fragments of chain	each	2	0
Doliolum tritonis .	per tube	1	6
Botryllus violaceus .	per col.	1	0
smaragdeus	,,	2	0
Botrylloides rubrum	,,	1	6
Styela aggregata .	per doz.	2	0
Styelopsis grossularia	,,	2	0
Polycarpa varians .	,,	9	0
Molgula oculata .	each	1	0
Perophora Listeri .	per col.	2	6
Ascidiella aspersa .	per doz.	5	0
scabra .	each	0	6
venosa .	,,	0	8
Ascidia depressa (Garstang)	,,	0	8
mentula .	,,	1	0
Phallusia mammillata	,,	1	6
Corella larvæformis .	,,	0	6
Ciona intestinalis .	,,	0	6
Diazona violacea .	per col.	2	0
Pycnoclavella aurilucens	,,	2	0
Clavelina lepadiformis	,,	2	0
Archidistoma aggregatum	,,	2	6
Distaplia rosea .	,,	1	0
Diplosoma Listeri .	,,	1	0
Leptoclinum sp. .	,,	1	0
Didemnum sp. .	,,	1	0
Circinalium concrescens	,,	2	6
Amaroucium Nordmanni	,,	2	6
proliferum	,,	2	6
Fragarium elegans .	,,	2	6
Morchellium argus .	,,	1	6

CEPHALOCHORDA.

		s.	d.
Amphioxus lanceolatus	each	0	9

In calm weather living specimens may be procured at 2/6 each.

PISCES.

Terminology is that of F. Day in *British Fishes.*

Unpreserved specimens at two-thirds of these prices.

ELASMOBRANCHII

		s.	d.
Mustelus vulgaris .	each	2	0
Galeus vulgaris .	,,	2	6
Scyllium canicula; Formalin-spirit	each	1	0
chromic	,,	1	3
embryos	,,	2	0
skeleton	,,	5	6

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		s.	d.
Scyllium catulus	each	2	0
embryos	,,	3	6
Acanthias vulgaris	,,	1	3
embryos	,,	1	0
Rhina squatina	,,	2	0
Raia batis	,,	4	6
clavata	,,	4	6
maculata	,,	4	6
blanda	,,	4	6
microcellatus	,,	4	6
circularis	,,	4	6
sp. embryos	,,	3	6
TELEOSTEI			
Acanthopterygii			
Labrax lupus	each	3	6
Mullus barbatus	,,	4	0
Pagellus centrodontus	,,	3	0
Trigla cuculus	,,	2	0
lyra	,,	2	0
gurnardus	,,	2	6
hirundo	,,	2	0
Cottus scorpius	,,	1	0
bubalis	,,	1	0
Agonus cataphractus	,,	1	0
Lophius piscatorius	,,	5	0
Trachinus draco	,,	2	6
vipera	,,	3	6
Scomber scomber	,,	2	0
Caranx trachurus	,,	2	0
Capros aper	,,	1	0
Zeus faber	,,	2	6
Gobius niger	,,	1	0
minutus	,,	0	6
ruthensparri	,,	0	6
paganellus	,,	0	6
Callionymus lyra	,,	0	9
Cyclopterus lumpus	,,	2	0
Blennius pholis	,,	1	0
gattorugine	,,	1	6
ocellaris	,,	1	0

		s.	d.
Centronotus gunellus	each	1	6
Mugil chelo	,,	3	6
Gasterosteus aculeatus	,,	1	0
spinachia	,,	1	0
Labrus maculatus	,,	2	0
Ctenolabrus rupestris	,,	2	6
Crenilabrus melops	,,	3	6
Anacanthini			
Gadus morrhua	each	3	6
luscus	,,	1	6
merlangus	,,	1	0
pollachius	,,	2	6
virens	,,	2	6
Merluccius vulgaris	,,	2	6
Molva vulgaris	,,	3	6
Motella tricirrata	,,	2	0
Ammodites tobianus	,,	1	0
Rhombus maximus	each 2/6 to 10/–		
lævis	each 2/6 to 10/–		
Arnoglossus laterna	each	1	0
Pleuronectes platessa	,,	1	0
limanda	,,	1	0
flesus	,,	1	0
microcephalus		1	6
Solea vulgaris	each	2	0
variegata	,,	2	6
lascaris	,,	2	0
Physostomi			
Engraulis encrasicholus	,,	1	6
Clupea harengus	,,	0	6
pilchardus	,,	0	6
sprattus	,,	0	6
Anguilla vulgaris	,,	1	6
Conger vulgaris	each 3/6 to 10/–		
Lophobranchii			
Syngnathus acus	each	1	0
Nerophis lumbriciformis	,,	1	0
aequorius	,,	1	0
Syphonostoma typhle	,,	1	0

ALGÆ.

THE following algæ have been carefully selected during the period in which the vegetative structure or reproductive organs are in a state suitable for laboratory work, and are put up in tubes at one shilling each. Larger quantities can be supplied to laboratories at a reduced rate.

PHÆOPHYCEÆ

Cystoseira ericoides
granulata
Pycnophycus tuberculatus
Ascophyllum nodosum
Fucus serratus
vesiculosus
Pelvetia canaliculatus
Himanthalia lorea
Desmarestia aculeata

Desmarestia viridis
Arthrocladia villosa
Sporochnus pedunculatus
Laminaria digitata
Scytoliphon tomentaria
Chorda filum
Lomantaria articulata
Cutleria multifida
Dictyota dichotoma
Dictyopteris polypodioides
Stilophora rhizodes
Asperococcus echinatus
bullosus
Litosiphon pusillus
Mesogloia Griffithsiana
viridis
Leathesia Berkeleyi
difformis
Elachista fucicola
flaccida
stellulata
scutulata
velutina
Myrionema sp.
Cladostephus verticillatus
Stypocaulon scoparium
Sphacelaria cirrhosa
Ectocarpus fasciculatus
Pilayella littoralis

Rhodophycæa

Rytiphlæa fruticulosa
Polysiphonia urceolata
elongata
byssoides
fastigiata
violacea
Dasya coccinea
Rhodomela subfusca
Bonnemaisonia asparagoides
Laurencia dasyphylla
Chylocladia kaliformis
Chylocladia clavellosa
Jania rubens
Corallina officinalis
Melobesia lithophyllum
Delesseria sanguinea
hypoglossum
Nitophyllum punctatum
Hilliæ
Stenogramme interrupta
Rhodymenia bifida
laciniata
Gracilaria confervoides
multipartita
Gelidium corneum
Gigartina mamillosa
Cystoclonium purpurascens
Chondrus crispus
Gymnogongrus plicatus
Polyides rotundus
Halymenia ligulata
Ginannia furcellata
Nemaleon multifidum
Dudresnaia coccinea
Ceramium ciliatum
decurrens
rubrum
Spyridia filamentosa
Wrangelia multifida
Helminthora divaricata
Callithamnion corymbosum
plumula
virgatulum
pedicellatum

Chlorophyceæ

Codium tomentosum
Bryopsis plumosa
Enteromorpha sp.
Ulva latissima
Porphyra sp.

Cyanophyceæ

Rivularia bullata

OBJECTS

OF THE

Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence, the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff. In no case does any one salary exceed £250.

The Association has received some £31,000, of which £15,000 has been granted by the Treasury. The annual revenue which can be at present counted on is about £1,820, of which £1,000 a year is granted by the Treasury, the remainder being principally made up in subscriptions.

The admirable Marine Biological Laboratory at Naples, founded and directed by Dr. Dohrn, has cost about £20,000, including steam launches, &c., whilst it has an annual budget of £7,000.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

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NOTICE.

The Council of the Marine Biological Association wish it to be understood that they do not accept responsibility for statements published in this Journal, excepting when those statements are contained in an official report of the Council.

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All correspondence should be addressed to the Director, The Laboratory, Plymouth.

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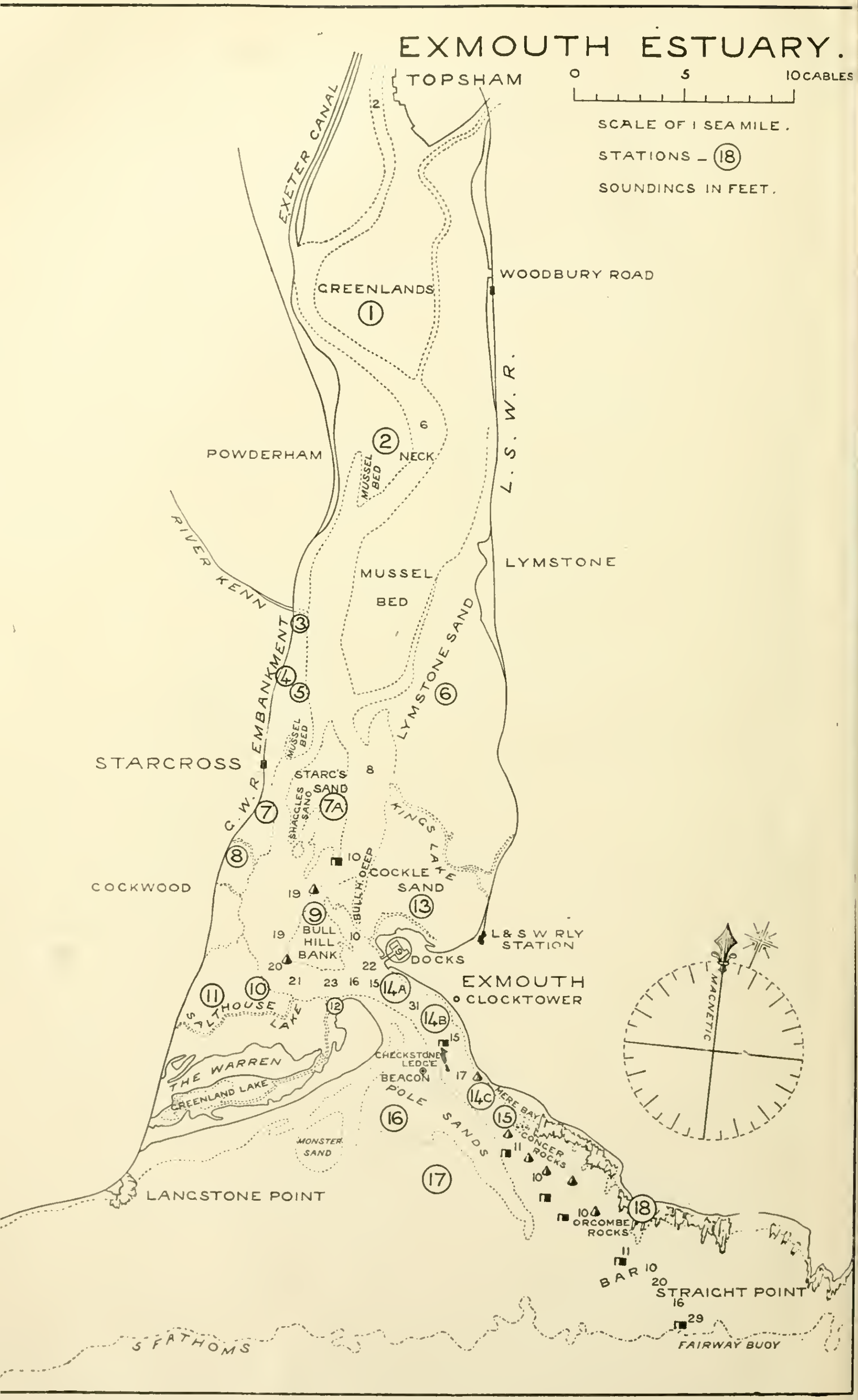
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POWDERHAM
RIVER KENN
MUSSEL BED
LYMSTONE
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1902

The Fauna of the Exe Estuary.

By

E. J. Allen, D.Sc., and R. A. Todd, B.Sc.

(With a Chart.)

I. Introduction.

In continuation of the scheme commenced last year for making a detailed survey of the marine fauna in the estuaries on the Devon and Cornish coasts, an examination has been undertaken during the present summer (1901) of the Exe estuary. For this purpose the floating laboratory boat *Dawn*, which has been generously placed at our disposal and maintained by Mr. J. W. Woodall, was towed to Exmouth and moored in the dock there, where she remained from July to September.

The principal means of collecting were hunting and digging on the shore between tide-marks; the use of a small trawl with a beam about four feet long fitted with a bag of mosquito netting; and the use of the dredge. The estuary, however, is not favourable for the use of the last-named instrument, as the ground is only suitable in the main channel, and the great strength of the tide makes the operation of dredging difficult excepting at slack water. Mr. Todd is almost entirely responsible for the collecting work, Dr. Allen only having paid occasional visits to Exmouth.

We have been able to combine with the collections made this summer the detailed records kept by Mr. E. W. L. Holt of some hauls with seine nets taken in the Exe estuary during two visits to Exmouth in the *Busy Bee* in 1897.

As regards the identification of the species, Dr. Allen is specially responsible for the Polychætes, Mr. Todd for Crustacea and Molluscs. An account of the examination by Mr. Worth of some samples of sand from the estuary, especially as regards the Foraminifera which they contained, is published in the present number of the Journal as a separate paper.

The estuary of the Exe differs markedly from the Salcombe estuary, which we examined last year (*vide Journ. Mar. Biol. Assoc.*, vol. vi. p. 151), both as regards its physical characteristics and the nature of its fauna, and a comparison of the two is interesting in several respects. Looking at the two faunas as a whole, it must be noted that that of the Exe estuary is very much more limited in number of species than that of Salcombe. This is particularly obvious when we exclude from the list of Exe species those which were obtained on the seaward side of the Polesands, a region which is really outside the estuary.

This limitation in the number of species living in the Exe estuary seems to a large extent to be due to the following causes. In the first place, the banks uncovered in the Exmouth estuary are left dry for a very long time between two tides, and in most parts of the estuary there is little difference in the area uncovered by the spring and neap tides. The banks of the low-water stream are generally steep, especially in the lower parts of the estuary, and the spring tides merely uncover a few additional feet of these steep banks. Hence it follows that the banks uncovered at Exmouth must really be regarded as belonging to a higher tidal level than the rich low-water banks exposed at spring tides in such harbours as Salcombe and Plymouth. When this is borne in mind the differences in fauna become far less striking, as these higher tidal levels are nowhere very rich in number of species. The actual rise and fall of tide at Exmouth is also less than at either Salcombe or Plymouth. The following figures are from King's *Pilot's Handbook for the English Channel* (12th edition):—

Exmouth. Springs rise 12¼ feet, neaps 8½ feet, and neaps range 5 feet.

Salcombe.* Springs rise 15 feet, neaps 11½ feet, and neaps range 6¾ feet.

The second point of importance is the very great strength of the tidal stream at Exmouth, both when it is running over the banks and to a still greater extent in the main channel when the banks are uncovered. The evidences of the great scour produced by the tide are numerous, and the soil of the banks is in many cases subject to such great disturbance that it is rendered practically barren so far as animal life is concerned.

A third point which requires consideration is the quantity of fresh water which enters the estuary. A proper knowledge of this question could only be arrived at by systematic observations carried out during the entire year, and more especially during the more rainy parts of the year. The following information, however, supplied to us by

---

* The figures for heights of tides given in the "Report on the Fauna of the Salcombe Estuary" (this Journal, vol. vi. p. 151) were taken from the Plymouth Tide Table, as information gathered locally led to the conclusion that the maximum rise inside the estuary was about 17 feet, which is practically the same as at Plymouth.

Mr. R. H. Worth, will be useful in comparing the Exe estuary with that of Salcombe. The watershed area draining to the Exe estuary is 584 square miles, the area draining to the Salcombe estuary is 33¼ square miles, and the rainfall over the two areas is about the same. It would not, however, be correct to say that with any given rainfall the flow of fresh water passing into the Salcombe estuary would therefore be only one-seventeenth of that passing into the Exe estuary, for both in summer and winter, but more especially in summer, the larger catchment would give a greater ordinary flow per unit area, whilst in time of exceptional flood this condition might be reversed and the smaller catchment would yield from twice to, in extreme cases, four times as much water per square mile. It would probably not be exaggerating the difference between the two estuaries to assume that the fresh water flowing into the Salcombe estuary is in summer one-thirtieth that flowing into the Exe estuary, in winter one-twentieth, at times of considerable flood one-tenth, and at times of great flood one-fifth. On the other hand, each flood of the Exe would last for a longer time than a flood at Salcombe.

The area of the Salcombe estuary at high tide is about half that of the Exe estuary, whilst at low tide, taking the whole length of each estuary, the two are more nearly equal in area. The Salcombe low-water channel is much the deeper, and the average rise and fall of tide is somewhat greater at Salcombe than at Exmouth. On the whole, therefore, it appears that the water of the Exe estuary must, at certain times at any rate, be of much less density than any which even in times of flood runs through the Salcombe estuary.

These conclusions are confirmed by the following observations of the density of the water in different parts of the estuary, made by Mr. Todd in December, after a night of heavy rain following a period of average rainfall (all samples taken at the surface):—

December 12th, 1901. High tide at Exmouth, 7.16 a.m. Neap tides.
[Height of tide at Plymouth, 14 ft. 11 ins.]

STARCROSS (Pier), 11.15 a.m. Temperature, 9·2° C.; density at that temperature, 1·021.
EXMOUTH (north side of Pier), 11.40 a.m. Temp., 9·7° C.; density, 1·0248.
EXMOUTH DOCK, 12.25 p.m. Temp., 9·4° C.; density, 1·0235.
EXMOUTH (south side of Pier), 12.35 p.m. Temp., 8·6° C.; density, 1·021.
" " " 12·50 p.m. Temp., 8.4° C.; density, 1·0208.
" " " 1.5 p.m. Temp., 8·4° C.; density, 1·0204.
TOPSHAM, 2 p.m. Temp., 11·9° C.; fresh water.
WOODBURY ROAD, 3.45 p.m. Temp., 8° C.; fresh water.
EXMOUTH (south side of Pier), 5.30 p.m. Temp., 9·8° C.; density, 1·0259.
STARCROSS (Pier), 6.5 p.m. Temp., 9·5° C.; density, 1·0262.

In order to illustrate the more striking differences between the faunas of the two estuaries, the following list of animals, which were common and characteristic species in the upper parts of Salcombe estuary (above Snape's Point), but are absent from the Exmouth fauna, may be given:—

Hymeniacidon sanguineum.
Sagartia bellis.
Carinella superba.
Phascolosoma pellucidum.
Nereis cultrifera.
Notomastus latericius.
Amphitrite Johnstoni.
Sabella pavonina.
Branchiomma vesiculosum.
Myxicola infundibulum.
Tapes pullastra.
Pecten opercularis.
Pecten maximus.
Calyptræa sinensis.
Scalaria communis.
Clavelina lepadiformis.
Morchellium argus.

Melinna adriatica, which occurred in immense profusion in the soft mud-flats in the upper parts of Salcombe estuary, was only represented at Exmouth by very occasional specimens. *Audouinia tentaculata*, which was very common above half-tide mark in the Salcombe estuary, was met with only at Orcombe Rocks, quite at the mouth of the Exe.

On the other hand, the following species from the Exe estuary above Exmouth town were either absent or represented only by occasional specimens at Salcombe:—

Nereis diversicolor.
Phyllodoce teres.
Eteone pusilla.
Nephthys cirrosa.
Ophelia bicornis.
Mytilus edulis.
Tellina balthica.
„ tenuis.
Hydrobia ulvæ.
Pleuronectes platessa (young specimens).

Cockles (*Cardium edule*) and *Scrobicularia piperata* were also very much more abundant at Exmouth than at Salcombe. On the sand-flats at Exmouth *Ulva* and *Enteromorpha* were very abundant, whilst *Zostera*, which was abundant and well grown at Salcombe, was less plentiful and generally had a much stunted habit.

II. Description of the Fauna found in different localities in the Exe Estuary.

STATION 1. GREENLANDS ZOSTERA BANK.

(See Chart.)

The highest part of the estuary examined was the Greenlands Zostera Bank, which is situated between Topsham and Powderham. The bank is about half a mile across, and is composed of fine mud almost entirely covered with zostera. The latter grows thickly together, but is small and stunted. The four abundant species are forms which are generally met with in estuarine waters of low density.

List of Species. Shore Collecting.

August 15th, 1901.

POLYCHÆTA.

Nereis diversicolor. Very common.
Arenicola marina. One.

CRUSTACEA.

Carcinus mænas. A few.

MOLLUSCA.

Scrobicularia piperata. Abundant.
Littorina littorea. Abundant.
Hydrobia ulvæ. Abundant.

Station 2. SAND BANK EAST OF POWDERHAM MUSSEL BEDS.

This bank is composed of smooth, fine sand with some admixture of mud, and possesses a very limited fauna.

List of Species. Shore Collecting.

August 16th, 1901.

POLYCHÆTA.

Nereis diversicolor. Several.
Nephthys Hombergii. Fairly common.
Scoloplos armiger. Several.
Arenicola marina. Very common.

CRUSTACEA.

Carcinus mænas. A few.
Crangon vulgaris. A few.
Gammarus locusta. A few.

List of Species. Mosquito Net Trawl.

July 25th, 1901.

CRUSTACEA.

Carcinus mænas. A few.
Crangon vulgaris. A few.
Macromysis flexuosa. Abundant.
Neomysis vulgaris. Thirteen.
Gammarus locusta. Several.

PISCES.

Gobius minutus. Four, 2·4-2·8 cm.
Pleuronectes platessa.
Syngnathus rostellatus. Four, 12·3–15·7 cm.

Station 3. SAND OFF MOUTH OF KENN RIVER, SOUTH OF POWDERHAM.

The sand here is more muddy than that found on the last bank described, and there are also patches of gravel. The fauna is increased by the addition of several molluscs, whilst *Scoloplos armiger* was not found.

List of Species. Shore Collecting.

JULY 16TH, 1901.

POLYCHÆTA.

Nereis diversicolor. Numerous, large.
Nephthys Hombergii. One.
Arenicola marina. Very common.

CRUSTACEA.

Crangon vulgaris. Small, common.
Macromysis flexuosa. Many.

MOLLUSCA.

Mytilus edulis. Several attached to stones.
Cardium edule. Common.
Tellina balthica. One.
Scrobicularia piperata. Common.
Littorina littorea. Not uncommon.

PISCES.

Gobius minutus. Small, common.

STATION 4. GRAVEL BETWEEN POWDERHAM AND STARCROSS.

Between STATION 3 and Starcross, close to the railway embankment, the ground is composed of muddy gravel, and the Polychæte fauna increases in richness. The estuarine *Nereis diversicolor* is still abundant, *Lanice conchilega* becomes plentiful, whilst *Arenicola marina*, the ground being gravel, is not so common.

List of Species. Shore Collecting.

SEPTEMBER 2ND, 1901.

POLYCHÆTA.

Nereis diversicolor. Very common.
Nephthys Hombergii. Several.
Glycera convoluta. Several.
Phyllodoce teres. Two.
Scoloplos armiger. A few.
Arenicola marina. A few.
Lanice conchilega. Common.
Melinna adriatica. Two.

MOLLUSCA.

Cardium edule. Common.
Tellina balthica. One.
Scrobicularia piperata. Not uncommon.

STATION 5. SAND BANK ABOVE STARCROSS.

On the bank of clean fine sand outside the gravel of STATION 4 the characteristic species of the upper parts of the estuary almost disappear, and we get a typical fauna characterised by *Nephthys cirrosa*, *Phyllodoce teres*, *Etcone pusilla*, *Haustorius arenarius*, and *Tellina tenuis*

List of Species. Shore Collecting.

September 2nd, 1901.

POLYCHÆTA.

Nephthys Hombergii. Common.
„ cirrosa. Common.
Phyllodoce teres.
Eteone pusilla. One.
Pygospio seticornis.
Arenicola marina. Very common.

CRUSTACEA.

Haustorius arenarius. One.

MOLLUSCA.

Cardium edule. A few.
Tellina tenuis. Not uncommon.

List of Species. Shrimp Trawl.

July 12th, 1901.

CRUSTACEA.

Carcinus mænas. A dozen.
Crangon vulgaris. A few.
Gammarus locusta. Many small.

MOLLUSCA.

Sepiola atlantica. One.

PISCES.

Syngnathus acus. Two.

Station 6. SAND AND MUD SOUTH OF LYMPSTONE MUSSEL BEDS.

List of Species. Shore Collecting.

August 6th, 1901.

POLYCHÆTA.

Scoloplos armiger. Common.
Ophelia bicornis. One.
Arenicola marina. Very common.

MOLLUSCA.

Mytilus edulis. Common.
Cardium edule. Common.
Tellina balthica. A few lying on the surface of the mud.
Tellina tenuis. Common at L.W.M. in sand.
Scrobicularia piperata. Very common in stiff mud.
Littorina littorea. Common on weed.
Hydrobia ulvæ. Very common on Enteromorpha and Zostera.

List of Species. Mosquito Net Trawl.

July 20th, 1901.

CRUSTACEA.

Carcinus mænas. One.
Crangon vulgaris. Small, common.
Macromysis flexuosa. Many.
Schistomysis Helleri. One or two.

PISCES.

Gobius minutus. One.

STATION 7. BETWEEN STARCROSS AND COCKWOOD.

In the first half the ground consists of gravel and shell débris, with a thin (½ to 2 inches) layer of muddy sand. As on the gravel of STATION 4, *Lanice conchilega* is very abundant, whilst *Arenicola marina* is not frequent.

List of Species. Shore Collecting.

SEPTEMBER 3RD, 1901.

POLYCHÆTA.

Arenicola marina. Occasional.
Lanice conchilega. Very common.

CRUSTACEA.

Carcinus mænas. Not uncommon.
Crangon vulgaris. Small, common.
Gammarus locusta. Common under stones, weed, etc.

MOLLUSCA.

Ostræa edulis. Three, near Starcross, on gravel.
Mytilus edulis. Several.
Cardium edule. Common.
Tapes pullastra. Shells only.
Tellina balthica. Two.
Scrobicularia piperata. Shells.
Littorina littorea. Common.
Hydrobia ulvæ. Shells very common.

STATION 7A. SAND BANK OFF STARCROSS.

List of Species. Mosquito Net Trawl.

JULY 10TH, 1901.

PORIFERA.

Leucosolenia sp.
Sycon ciliatum (?). One or two.

CRUSTACEA.

Carcinus mænas. Several.
Crangon vulgaris. Small, common.
Macromysis flexuosa. Many.
Idothea balthica. Two.
Bathyporeia pelagica. Twenty.
Gammarus locusta. A few.

PISCES.

Agonus cataphractus. One, 4·4 cm.
Gobius minutus.
Rhombus lævis. One, about 2 cm.
Pleuronectes platessa. Four, 4·3–6·0 cm.
Syngnathus rostellatus. One.

STATION 8. BETWEEN STARCROSS AND COCKWOOD.

The ground now described lies to the south of STATION 7, and differs from it in being more sandy and less muddy. The soil consists of gravel and shell débris, covered with about six inches of sand. In consequence of this change in the character of the soil there is a considerable increase in the Polychæte fauna, whilst Molluscs almost disappear.

List of Species. Shore Collecting.

SEPTEMBER 3RD, 1901.

POLYCHÆTA.

Nephthys Hombergii. Many.
Phyllodoce maculata (?).
Eteone pusilla.
Pygospio seticornis.
Scoloplos armiger. Common.
Aricia Latreillii. One small one.
Arenicola marina. Very common.
Praxilla sp. Small, with irregular papillæ on anus.
Lanice conchilega. Not uncommon.
Melinna adriatica. Two.

MOLLUSCA.

Patella vulgata. Not uncommon on stones.

STATION 9. BULLHILL BANK.

On this bank the soil varies considerably. Where first uncovered it is composed of coarse and loose sand, and here practically the sole inhabitant is *Ophelia bicornis.* At lower levels the sand is finer and firmer, whilst in places it only thinly covers a soil of coarse gravel. There was a large quantity of Enteromorpha growing on the bank.

List of Species. Shore Collecting.

JULY 4TH, 1901.

POLYCHÆTA.

Nereis longissima. One.
Nephthys Hombergii. One or two.
„ cæca. Several large specimens.
Nephthys cirrosa. Many in the sand, one or two fairly large.
Glycera convoluta. Two.
Pygospio seticornis. Plentiful in the sand.
Nerine cirratulus. Two.
Scoloplos armiger. Several.
Arenicola marina. Several.
Ophelia bicornis. Common in loose sand.
Lanice conchilega. Fairly common.

CRUSTACEA.

Carcinus mænas. Occasional.
Crangon vulgaris. Small, very common.

MOLLUSCA.

Mytilus edulis. Young ones swarmed on Enteromorpha.
Cardium edule. Common on the fine sand to the north.
Tapes decussata. Several.
Tellina tenuis. Several.
Solen vagina. One in sand.
Littorina littorea. Very common on weeds at extreme north.

PISCES.

Gobius minutus. Common.

List of Species. Mosquito Net Trawl.

JULY 8TH, 1901.

CRUSTACEA.

Carcinus mænas. Several.
Crangon vulgaris. Small, common.
Macromysis flexuosa. Common.
Schistomysis Helleri. Common.
Idothea balthica. Common.
Bathyporeia pelagica. One.
Gammarus locusta. Common.

MOLLUSCA.

Cardium edule. One.
Tellina tenuis. One.
Hydrobia ulvæ. A few.

PISCES.

Gobius minutus. Four, 1·2–5·7 cm.
Gasterosteus spinachia. Four small.
Pleuronectes platessa. One, 4·7 cm.

BULLHILL BANK. GRAVEL ON WEST SIDE.

List of Species. Mosquito Net Trawl.

JULY 26TH AND 28TH, 1901.

CRUSTACEA.

Crangon vulgaris. A few.
Pagurus Bernhardus. Several young.
Gastrosaccus spinifer. Nine.
Macromysis flexuosa. A dozen.
Idothea linearis. One small one.
Sphæroma serratum. Common.
Synchelidium sp. One.
Gammarus locusta. Several young.
Melita palmata. One.

PISCES.

Gobius minutus. One, 2·7 cm.
Blennius pholis. One, 2·1 cm.

BULLHILL DEEP PIT.

List of Species. Mosquito Net Trawl.

JULY 26TH, 1901.

CRUSTACEA.

Stenorhynchus phalangium. Three.
Carcinus mænas. Several.
Crangon vulgaris. A few.
Hippolyte varians. Several small.
Palæmon serratus. Four large.
Macromysis flexuosa. Four.
Gammarus locusta.

MOLLUSCA.

Mytilus edulis. Young ones common.
Elysia viridis. Three.

PISCES.

Gobius minutus. One, 5·0 cm.
Labrus maculatus. Five, 1·4–3·0 cm.
Crenilabrus melops. Four, 1·2–2·5 cm.

BULLHILL BANK.

List of Species. Professional Seine.

April 7th, 1897. From Records made by Mr. E. W. L. Holt.

PISCES.

Cottus bubalis. Several.
Agonus cataphractus. Ten.
Motella mustela. One.
Pleuronectes platessa. Sixty-three. (For details see p. 333.)
Pleuronectes flesus. One, 12·5 cm.
Clupea harengus. Two, 26 and 29 cm.

List of Species. Laboratory Tuck Net.

May 31st, 1897. E. W. L. H.

MOLLUSCA.

Doris tuberculata. One.

PISCES.

Cottus bubalis. One.
Trigla hirundo. Five, 14–23 cm.
Agonus cataphractus. Several.
Trachinus vipera. Two.
Callionymus lyra. One.
Mugil chelo. One, 24 cm.
Pleuronectes platessa. One hundred and thirty-one. (For details see p. 334.)
Pleuronectes limanda. Eleven, 9·5–13 cm.
Pleuronectes flesus. Four, 9·5–17 cm.
Clupea sprattus (?). Six, of 5 cm.

Station 10. SAND WEST OF THE MOUTH OF SALTHOUSE LAKE.

Immediately to the west of the entrance to Salthouse Lake the soil consists of fine sand with some admixture of mud. This is the only locality where *Solen vagina* was found.

List of Species. Shore Collecting.

July 15th, August 31st, 1901.

POLYCHÆTA.

Evarne impar. One under a tile.
Nephthys Hombergii. Small, common.
Phyllodoce teres.
Eteone pusilla. A few.
Pygospio seticornis. Numerous.
Heteromastus filiformis. A few.
Nerine coniocephala. A few.
Scoloplos armiger.
Arenicola marina. Common.
Clymenids. (Praxilla.) Probably two species; in clean sand.
Lanice conchilega. In sand.

MOLLUSCA.

Cardium edule. Common.
Solen vagina. Not uncommon.
Littorina littorea. Common.

Station 11. MUD NORTH OF SALTHOUSE LAKE.

To the west of Station 10 along the bank of the stream a considerable quantity of mud is met with, which in some places is soft and sticky, in others hard and of a more clayey nature.

List of Species. Shore Collecting.

July 15th, 1901.

Nereis diversicolor. Common where mud was hard.
,, longissima. One.
Nephthys Hombergii. Common, small.
Nerine coniocephala. Not uncommon in hard mud.
Scoloplos armiger. Not uncommon in hard mud.
Arenicola marina. Common.

CRUSTACEA.

Carcinus mænas. Many young.
Crangon vulgaris. Many young.
Macromysis flexuosa. One.
Corophium grossipes. Common burrowing in hard mud.

MOLLUSCA.

Cardium edule. Common.
Tellina balthica. One.
Scrobicularia piperata. Common.
Littorina littorea. Common.

List of Species. Mosquito Net Trawl.

July 24th, 1901.

CRUSTACEA.

Carcinus mænas. Several.
Crangon vulgaris. Small, very common.
Macromysis flexuosa. A dozen.
Schistomysis Helleri. Many.

PISCES.

Gobius minutus. Twenty, 1·2–4·5 cm.

SALTHOUSE LAKE.

List of Species. Shrimp Net.

July 18th, August 5th and 31st, 1901.

CRUSTACEA.

Carcinus mænas. Common.
Crangon vulgaris. Common.

PISCES.

Gobius minutus. Common.
Ammodytes tobianus. One, 9·3 cm.
Rhombus lævis. Three, 2·8–3 cm.
Pleuronectes platessa. About 130, from 4–16 cm. in length. (See p. 334.)
,, flesus. Four, 13·5–14 cm.
Syngnathus acus. Several.

BETWEEN THE WARREN AND COCKWOOD.

List of Species. Professional Seine.

April 7th, 1897. From records made by Mr. E. W. L. Holt.

PISCES.

Labrax lupus. One, 15·5 cm.
Cottus bubalis. Ten.
Agonus cataphractus. Three.
Gobius minutus. Two.
Gasterosteus spinachia. Two.
Rhombus maximus. One, 14 cm.
„ lævis. One, 14 cm.
Pleuronectes platessa One hundred and sixty-five. (For details see p. 333.)
Pleuronectes limanda. One, 9 cm.
Clupea harengus. Six, 23·5–32·5 cm.
„ sprattus. Six, 5·5–7 cm.
Syngnathus acus. Two.

List of Species. Laboratory Tuck Net.

May 29th, 1897.

PISCES.

Labrax lupus. Two, 8 and 72 cm.
Cottus bubalis. One.
Agonus cataphractus. Four.
Callionymus lyra. One.
Rhombus lævis. Two, 17 and 21·5 cm.
Pleuronectes platessa. Seventy-seven. (For details see p. 334.)
Pleuronectes limanda. Eight, 9·5–11·5 cm.
Pleuronectes flesus. Two, 13 and 30·5 cm.

Station 12. NORTH SIDE OF WARREN. EAST BANK OF STREAM DRAINING GREENLAND LAKE.

At the north-eastern end of the Warren the shore is composed of loose gravel, which is practically barren on account of the great force of tide to which it is exposed. Along the bank of the stream which drains Greenland Lake, however, the soil becomes firmer, and consists of muddy sand with a large proportion of gravel mixed with it. As on the grounds higher up the estuary, this mixture of sand and gravel affords specially suitable soil for *Lanice conchilega*, which occurs in very great profusion, whilst in patches near low-water mark the Gephyrean *Phascolosoma vulgare* is abundant, this being the only spot in the estuary at which it has been found. Ground of this nature is also favourable to *Tapes decussata*.

List of Species. Shore Collecting.

August 4th, 1901.

GEPHYREA.

Phascolosoma vulgare. Common in patch at low-water mark.

POLYCHÆTA.

Nephthys Hombergii. Several.
Arenicola marina. Common in sand.
Ophelia bicornis. One in clean sand.
Lanice conchilega. Extremely common at low-water mark, and in the bed of the stream.

CRUSTACEA.

Haustorius arenarius. One in clean sand.

MOLLUSCA.

Cardium edule. Several.
Tapes decussata. Common.
Tellina tenuis. One in sand.
Scrobicularia piperata. A few in muddy sand.
Trochus cinerarius. A few.
Littorina littorea. Not uncommon.

POLYZOA.

Loxosoma phascolosomatum. Not uncommon on the posterior end of *Phascolosoma.*

Station 13. COCKLESAND.

The soil on this bank consists of sand and sandy mud of varying consistency, covered in places with Zostera and Enteromorpha, the fauna being very similar to that of grounds of this character already described. This bank remains uncovered for a considerable time between each tide.

List of Species. Shore Collecting.

July 7th, 13th, 22nd, 1901.

POLYCHÆTA.

Nereis diversicolor. Not uncommon in muddy sand.
Nephthys cirrosa. One.
„ Hombergii. Several taken.
Pygospio seticornis. Very common in sand.
Nerine cirratulus. A few.
Scoloplos armiger. A few.
Arenicola marina. Abundant.
Ophelia bicornis. One in clean sand.
Lanice conchilega. A few.
Melinna adriatica. A few in Zostera bed.

CRUSTACEA.

Carcinus mænas. Small, not uncommon among weed.
Crangon vulgaris. Small, common.
Schistomysis Helleri. Three.
Talitrus locusta. Common in sand and weed at high tidal levels.

INSECTA.

Heterocerus femoralis. Common burrowing in fine, loose sand.

MOLLUSCA.

Mytilus edulis. Several.
Cardium edule. Very common on or just below the surface.
Tapes decussata. Several where the ground was coarse.
Tellina balthica. Common lying on the surface of the mud.
„ tenuis. Not uncommon in sand.
Scrobicularia piperata. Very common in stiff mud.
Littorina littorea. Very common on weed.
Hydrobia ulvæ. Very common among weed.

List of Species. Mosquito Net Trawl.

July 22nd, 1901.

CRUSTACEA.

Carcinus mænas. Small and medium-sized ones common in Kingslake; a few on Cocklesand.
Crangon vulgaris. Small, common.
Palæmon serratus. One small one, Kingslake.
Macromysis flexuosa. Common.
Schistomysis Helleri. Common, Kingslake.
Idothea balthica. Several, Cocklesand.
Gammarus locusta. Several small, Kingslake.

MOLLUSCA.

Littorina littorea. A few.
Hydrobia ulvæ. A few.

PISCES.

Gobius minutus. One or two.
Ammodytes tobianus. One, Kingslake.

CHANNEL BETWEEN BULLHILL BANK AND COCKLESAND.

List of Species. Mosquito Net Trawl.

July 19th, 1901.

CRUSTACEA.

Stenorhynchus phalangium. One.
Carcinus mænas. Common.
Pagurus Bernhardus. One or two.
Crangon vulgaris. Common.
Hippolyte varians. Two.
Palæmon serratus. One.
Macromysis flexuosa. Several.
Schistomysis Helleri. One or two.
Paratylus Swammerdami. Four.
Gammarus locusta. Small, common.

MOLLUSCA.

Mytilus edulis. Several.
Cardium edule. One.
Littorina littorea. A few.
Hydrobia ulvæ. A few.
Aplysia punctata. Spawn.

PISCES.

Cottus bubalis. Four, 4·0–11·7 c.m.
Gobius minutus. Several, 1·8–5·3 c.m.
Labrus maculatus. Two, 2·0–2·5 c.m.
Crenilabrus melops. Eleven, 1·0–2·1 cm.

Station 14. CHANNEL BETWEEN PIER AND MOUTH OF HARBOUR.

The fauna in the channel of the estuary now under consideration consists of a very limited number of species. From the pier to a point about half-way towards the Checkstone Ledge the dredge brought up a number of rounded stones, obviously much worn by the scour of the tide, and with very few animals living amongst them. The tidal stream is here very rapid.

STATION 14A. FIRST HALF OF CHANNEL FROM PIER TO CHECKSTONE LEDGE.

List of Species. Dredge.

JULY 9TH, 1901.

HYDROZOA.

Sertularia argentea. Common on stones.

ECHINODERMA.

Echinus miliaris. One small.

CRUSTACEA.

Pagurus Bernhardus. Two small.
Amphithoë rubricata. Two.
Aora gracilis. Two.

MOLLUSCA.

Mytilus edulis. One large; many very small.
Tapes pullastra. Shells.
Buccinum undatum. Three small.

Proceeding down the estuary, the portion between that last described and the Checkstone Ledge was found to be occupied by large masses of the sponge *Halichondria panicea*, with which the dredge was almost filled. A limited fauna was associated with this sponge, as detailed below.

STATION 14B. SECOND HALF OF CHANNEL FROM PIER TO CHECKSTONE LEDGE.

[Sponge Ground off Clock Tower.]

List of Species. Dredge.

JULY 9TH, 1901.

PORIFERA.

Halichondria panicea. The dredge came up filled with large masses of this sponge.

HYDROZOA.

Tubularia sp. Several very small colonies.

ECHINODERMA.

Amphiura elegans. One or two.
Ophiothrix fragilis. Several small.

TURBELLARIA.

Leptoplana tremellaris. One.

POLYCHÆTA.

Euphrosyne foliosa. One.
Nereis pelagica. Several specimens.
Polymnia nebulosa. Small specimens.

CRUSTACEA.

Cancer pagurus. One very small one.
Carcinus mænas. Very small, common.
Porcellana platycheles. One.
Dexamine spinosa. A few.
Gammarus locusta. Several.
Amphithoë rubricata. One.
Aora gracilis. Two.

MOLLUSCA.

Mytilus edulis. Young, very common.
Tapes virginea. One small one.
Rissoa parva. One.
Nassa incrassata. One.

POLYZOA.

Scrupocellaria scruposa. Several colonies on sponge.

Below the Checkstone Ledge the bottom of the channel is covered with large masses of mussels (*Mytilus edulis*), which afford a regular fishery to a number of small boats (cf. p. 326). The mussels are often united together into large masses eight inches or a foot in diameter. Only a few other species are associated with the mussels.

STATION 14C. MUSSEL BANK.

List of Species. Dredge.

JULY 9TH, 1901.

ECHINODERMA.

Amphiura elegans. One.

TURBELLARIA.

Leptoplana tremellaris. One.

POLYCHÆTA.

Sthenelais boa. One.

CRUSTACEA.

Carcinus mænas. Several.
Pagurus Bernhardus. One.
Melita palmata. One.

MOLLUSCA.

Mytilus edulis. Abundant.
Buccinum undatum. One small.

Beyond the mussel bed the dredge brought up only clean stones.

STATION 15. MERE BAY.

List of Species. Mosquito Net Trawl.

AUGUST 7TH, 1901.

CRUSTACEA.

Stenorhynchus phalangium. One.
Crangon vulgaris. Common.
Palæmon serratus. Several small.
Macromysis flexuosa. Many.
Gammarus locusta. Common.

PISCES.

Gobius minutus. Four, 2·0–5·0 cm.
Blennius pholis. Two, 2·0–2·5 cm.
Gasterosteus spinachia. One, 5·2 cm.
Labrus maculatus. One small one.
Crenilabrus melops. Twenty-four, 2–3·1 cm.

List of Species. Professional Seine.

APRIL 8TH, 1897. FROM RECORDS MADE BY MR. E. W. L. HOLT.

PISCES.

Cottus bubalis. Several.
Ammodytes (tobianus ?). Many.
Rhombus lævis. Two, 18 cm.
Pleuronectes platessa. Seventy-three. (For details see p. 333.)
Salmo sp. One, 34 cm.

STATION 16. POLESANDS.

Polesands is a large triangular sand bank, situated at the mouth of the Exmouth estuary, which is uncovered at low water. The bank, along its north-eastern edge, forms the border of the main channel of the estuary, and is consequently under the influence of the full force of the tidal stream. The sand on this side is somewhat coarse and loose, and the edge of the bank at low water is steep. In this loose sand the only animal found was the Polychæte *Ophelia bicornis*, which lives there in great abundance.

The southern side of the Polesands faces the open water of the English Channel, and is therefore at times subject to the influence of powerful wave-action. The sand is here fine but firm, and shelves very gently, leaving extensive flats uncovered at low spring tides. In spite of the exposed situation, many interesting sand-burrowing animals are found, forming a fauna which differs much from that of the sand banks inside the estuary. The most characteristic species are *Aricia Latreillii*, *Portunus holsatus*, *Portumnus variegatus*, *Tellina tenuis*, *Donax vittatus*, *Mactra solida*, *Solen ensis*, *Solen siliqua*, and *Natica catena*. A large Nemertine, at present unidentified, was also found here.

List of Species. Shore Collecting.

JULY 14TH, 17TH, AUGUST 3RD, SEPTEMBER 1ST, 1901.

HYDROZOA.

Perigonimus repens. A few colonies growing on *Donax*.
Sertularia argentea. A few pieces.

ECHINODERMA.

Echinocardium pennatifidum. A few broken pieces.

POLYCHÆTA.

Nephthys Hombergii. Common.
,, cirrosa. Common.
Aricia Latreillii. Not uncommon.
Arenicola marina. One or two.
Ophelia bicornis. Common in coarse loose sand.

CRUSTACEA.

Carcinus mænas. Not uncommon.
Portunus holsatus. Two.
Portumnus variegatus. Eight buried in sand ; many cast shells.
Corystes cassivelaunus. One ♀ in berry.
Pagurus Bernhardus. One.
Crangon vulgaris. Common.
Haustorius arenarius. Common ; buried in the sand.

MOLLUSCA.

(Living.)

Anomia ephippium. Three on shell of
Mytilus edulis. Several. [*Trochus magus.*
Cardium echinatum. Three.
„ norvegicum. Two.
Venus gallina. One.
Tellina tenuis. Very common at low-water mark, 2–3 inches below the surface.
Donax vittatus. Very common at low-water mark.
Mactra solida. Common.
Solen ensis. Not uncommon.
„ siliqua. Not uncommon.
Trochus umbilicatus. One.
Natica catena. A dozen.
Purpura lapillus. One.

(Shells only.)

Ostræa edulis.
Pecten maximus.
„ opercularis.
Diplodonta rotundata.
Cardium aculeatum.
Venus chione.
Mactra stultorum.
Lutraria elliptica.
Trochus magus.
Turritella terebra.
Buccinum undatum.
Cypræa europæa.

EAST BANK OF POLESANDS.

List of Species. Professional Seine.

July 14th, 1901.

PISCES.

Labrax lupus. One or two.
Trachinus (vipera ?). One.
Mugil chelo. One.
Ammodytes tobianus. Very many.
Rhombus lævis. One.
Pleuronectes limanda. One or two.
„ platessa. One or two.
Belone vulgaris. One.

Station 17. GROUNDS OUTSIDE POLESANDS.

BETWEEN POLE AND MONSTER SANDS.

List of Species. Mosquito Net Trawl.

July 23rd, 1901.

CRUSTACEA.

Crangon vulgaris. A few.
Schistomysis Parkeri. One.
Paratylus Swammerdami. Two.
Gammarus locusta. Several.

MOLLUSCA.

Hydrobia ulvæ. Several.

PISCES.

Agonus cataphractus. One, 4·8 cm.
Gasterosteus spinachia. One.
Syngnathus rostellatus. Two, 7·4 and 13·4 cm.

QUARTER-MILE SOUTH OF POLESANDS.

List of Species. Mosquito Net Trawl.

July 19th, 1901.

CRUSTACEA.

Stenorhynchus phalangium. Four.
Carcinus mænas. One small one.
Portunus depurator. One.
Pagurus Bernhardus. One.
Crangon vulgaris. Many large.
Hippolyte varians. One.
Leptomysis mediterranea. Two.
Leptomysis lingura. One.
Macromysis flexuosa. One.
Idothea balthica. Several.
„ linearis. A few.
Paratylus Swammerdami. Four.
Gammarus locusta.

MOLLUSCA.

Trochus magus. One small one.
Philine aperta. One.

PISCES.

Syngnathus rostellatus. Seven, 5·9–14·9 cm.

THE BAR.

List of Species. Mosquito Net Trawl.

July 27th, 1901.

CRUSTACEA.

Carcinus mænas. Three, two with *Sacculina*.
Crangon vulgaris. Many, some large.
Hippolyte varians. One.
Idothea linearis. Several.
„ balthica.
Paratylus Swammerdami. Several.
Gammarus locusta. Common.
Sacculina carcini. Two on *Carcinus*.

PISCES.

Syngnathus rostellatus. Seven, 5·8–11·5 cm.

Station 18. ORCOMBE ROCKS.

The rocks are of red sandstone, and are so situated that, although often exposed to the full force of the Channel seas, their fauna must be largely influenced by the water flowing out of the estuary of the Exe.

List of Species. Shore Collecting.

August 17th, 1901.

PORIFERA.

Sycon compressum. Common.
Halichondria panicea. Very common.

HYDROZOA.

Sertularia pumila. Common.

ACTINOZOA.

Actinia mesembryanthemum. Common.
Anthea cereus. Common.

ECHINODERMA.

Amphiura elegans. Common.

POLYCHÆTA.

Lepidonotus clava. Not uncommon.
Marphysa sanguinea. One or two.
Nereis cultrifera. One.
„ fucata. One in shell with *Eupagurus Bernhardus*.
Nereis irrorata. One.
Eulalia viridis. A few.
Audouinia tentaculata. One.
Sabellaria alveolata. Very common.
Pomatoceros triqueter. Several.

CRUSTACEA.

Cancer pagurus. Small.
Portunus puber. A few.
Porcellana platycheles. Common.
Pagurus Bernhardus. Small, common.
Gnathia maxillaris.
Idothea balthica.

MOLLUSCA.

Mytilus edulis. Young, very common.
Kellia suborbicularis. One.
Saxicava rugosa. Common.
Pholas dactylus. Common.
„ parva. Common.
Patella vulgata. Very common.
Trochus cinerarius. Shells.
Rissoa parva. One.
Purpura lapillus. Very common.
Buccinum undatum. Shells.
Cypræa europæa. A few.

POLYZOA.

Membranipora membranacea. Common.
Bugula turbinata. Common.

PISCES.

Blennius pholis. Common.
Ammodytes tobianus. One.

STATION 19. EXMOUTH DOCK.

As the *Dawn* was moored in Exmouth Dock opportunities were constantly offered for observations on the fauna there found. The dock gates are opened daily, generally about an hour before high water. The dock itself being small, the water in it is in this way very frequently changed, and a considerable number of animals flourish in the sheltered situation which it provides. During the present summer one of the most interesting features of this dock fauna was the immense profusion of the Ascidian *Ciona intestinalis*, which covered the wall and piles underneath the Engineering Company's stage on the eastern side of the dock. The two walls immediately inside the dock gates were also covered with these Ascidians (cf. also p. 330). The Polyzoan *Bugula turbinata* covered the bottom of the *Dawn* and other boats which remained in dock during the summer, and considerable numbers of *Ascidiella aspersa* and *Ciona intestinalis* were found in the same situation.

List of Species.

PORIFERA.

Sycon ciliatum (?). Common on the piles.

HYDROZOA.

Hydractinia echinata. On shell inhabited by *Pagurus* from prawnpot.

POLYCHÆTA.

Small *Nereids*, probably young *N. diversicolor*.
Polymnia nebulosa. Small specimens from amongst the Ascidians under stage.

CRUSTACEA.

Cancer pagurus. A few small ones seen.
Carcinus mænas. Common.
Portunus puber. Several small and large seen.
Pagurus Bernhardus. One caught in prawnpot.
Homarus vulgaris. Not uncommon in holes in the dock walls.
Palæmon serratus. Common.
Macromysis flexuosa. Common.
Schistomysis Helleri. One.
Ligia oceanica. Common on the walls above water-level.
Dexamine spinosa. One or two.
Gammarus locusta. Not uncommon on the piles, among weed, etc.
Notopterophorus gibber. Not uncommon in pharyngeal cavity of *Ciona*.
Bopyrus squillarum. Two parasitic on *Palæmon*.

MOLLUSCA.

Anomia ephippium. One on dock wall.
Elysia viridis. One or two on piles.
Antiopa cristata. Several on walls, piles, and boats in dock.

POLYZOA.

Bugula turbinata. Common underneath stage and on boats.

TUNICATA.

Ciona intestinalis. Extremely common on the piles and wall underneath the Engineering Company's stage, on the dock walls between the swing bridge and the dock gates, and in less quantity on the bottoms of various boats.
Ascidiella aspersa. Common in same situations as *Ciona*.

PISCES.

Gobius Ruthensparri. Common, one caught. 5·3 cm.
,, paganellus. Several caught in prawnpot. 10·1, 7·2, 5·9, 5·1, 8·0 cm.
Blennius pholis. Common in crevices in wall.
Atherina presbyter. A shoal seen (Aug. 16th); those captured measured ·7-1·1 cm.
Mugil chelo. Large ones common; a shoal of young ones seen (Aug. 16th, 1901).
Gasterosteus aculeatus. One caught (Aug. 16th) among young grey mullet (Mugil chelo).
,, spinachia, 2·5 cm.
Labrus maculatus. One caught, 15·0 cm. long.
Crenilabrus melops. Several caught, 7·7 cm.
Gadus pollachius. One caught, 4 cm. long.
Ammodytes tobianus. Shoals common.
Anguilla vulgaris. Two caught, about 23 cm.
Conger vulgaris. One of about 4 lbs. seen.
Syngnathus rostellatus. Several caught.

III. A Complete List of the Species Identified, with an Account of their Local Distribution.

ACTINOZOA.

[Nomenclature: GOSSE, *British Sea Anemones and Corals.*]

ANTHEA CEREUS (*Ellis and Solander*). Not uncommon among Orcombe Rocks.

ACTINIA MESEMBRYANTHEMUM, *Ellis and Solander.* Common among Orcombe Rocks.

Anemones were only found at Orcombe Rocks at the mouth of the harbour. None were seen within the estuary itself. The absence of *Sagartia bellis*, which is so common on the mud-flats at Salcombe and in the Yealm, is noteworthy, but is probably explained by the fact that a stony ground, covered with a moderately thin layer of mud, such as this species requires, is not met with in the Exe.

PORIFERA.

HALICHONDRIA PANICEA, *Pallas.* Dredged in large quantities in the channel between the pier and Checkstone Ledge (sta. 14B). The sponge occurred in large masses, less dense in structure and with a looser and more fibrous skeleton than the variety of this species commonly found on rocks on the shore. (See note by Mr. Bidder, p. 380, to whom we are indebted for the examination and identification of the specimens.) The shore variety occurred at Orcombe Rocks.

SYCON COMPRESSUM, found at Orcombe Rocks, and S. CILIATUM (?) in Exmouth Dock.

HYDROZOA.

[Nomenclature: HINCKS, *British Hydroid Zoophytes.*]

HYDRACTINIA ECHINATA (*Fleming*). A colony from the dock on *Buccinum* shell inhabited by *Pagurus Bernhardus.*

PERIGONIMUS REPENS (*T. S. Wright*). A few colonies on the posterior ends of *Donax vittatus*, from Polesands.

SERTULARIA PUMILA, *Linn.* Common at Orcombe Rocks.

SERTULARIA ARGENTEA, *Ellis and Solander.* Dredged in channel (sta. 14B): found on Polesands.

ECHINODERMA.

[Nomenclature: JEFFREY BELL, *Catalogue of British Echinoderms in the British Museum.*]

OPHIOTHRIX FRAGILIS (*O. F. Müller*). A few small ones dredged on the sponge ground in the channel (sta. 14B).

AMPHIURA ELEGANS (*Leach*). Common under stones at Orcombe Rocks. A few dredged on the sponge ground (sta. 14B).

ECHINUS MILIARIS (*Gmelin*). One dredged in the channel off the pier (sta. 14A).

GEPHYREA.

PHASCOLOSOMA VULGARE, *Blainville.* Common in a small patch of muddy sand with large gravel, at low-water mark, on the east side of the stream draining Greenland Lake (sta. 12). Many of the specimens had colonies of *Loxosoma phascolosomatum* growing on the posterior end. As at Salcombe, the ground where this species was found was very limited in size, but the number of specimens obtained was considerable. The nature of the soil, however, in which the species lived at Exmouth differed considerably from the stiff clay-gravel lying on hard clay in which it was found at Salcombe.

TURBELLARIA.

LEPTOPLANA TREMELLARIS (*O. F. Müller*). One dredged on the sponge ground off the Clock Tower (sta. 14B), and one on the mussel bank (sta. 14C).

POLYCHÆTA.*

[Nomenclature: DE SAINT-JOSEPH, "Les Annélides Polychètes des Côtes de Dinard," *Ann. Sci. Nat. Zoologie*, 1887-95; "Les Annélides Polychètes des Côtes de France (Manche et Océan)," ditto, 1898.]

EUPHROSYNE FOLIOSA, *Audouin et Edwards.* One specimen only dredged on the sponge ground (sta. 14B).

LEPIDONOTUS CLAVA, *Montagu.* Not uncommon on the shore at Orcombe Rocks.

EVARNE IMPAR, *Johnston.* One specimen was found hiding under a tile on the sand west of the mouth of Salthouse Lake (sta. 10).

STHENELAIS BOA, *Johnston.* One specimen was dredged on the mussel bed in the channel below Checkstone Ledge (sta. 14C). It was never met with on the shore between tide-marks, as at Salcombe and Plymouth.

MARPHYSA SANGUINEA, *Montagu.* One specimen only, from Orcombe Rocks.

NEREIS CULTRIFERA, *Grube.* Only met with at Orcombe Rocks, quite at the mouth of the estuary, and there but one specimen was found. This is noteworthy, as *N. cultrifera* is one of the commonest species found on the shore both in Plymouth Sound and in the Salcombe estuary.

NEREIS PELAGICA, *Linn.* A few specimens amongst the masses of sponge (*Halichondria panicea*) dredged in the main channel below the pier (sta. 14B).

NEREIS FUCATA, *Savigny.* Found once in a shell inhabited by *Eupagurus Bernhardus* taken at Orcombe Rocks.

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* By E. J. ALLEN.

NEREIS DIVERSICOLOR, *O. F. Müller.* Very common in the upper parts of the estuary, especially in the mud at Greenlands (sta. 1), at the mouth of Kenn River (sta. 3), below Powderham (sta. 4), and on the mud north of Salthouse Lake (sta. 11). A few were taken east of Powderham mussel beds (sta. 2) and in muddy sand at Cocklesand (sta. 13). As is usually the case, this species is most abundant where the water is of low density.

NEREIS IRRORATA (*Malmgren*). One specimen only outside the estuary at Orcombe Rocks.

NEREIS LONGISSIMA, *Johnston.* One specimen on Bullhill Bank, and one on the mud north of Salthouse Lake (sta. 11). The rarity of this species is noteworthy, as it was abundant in fine muddy sand in the upper parts of Salcombe estuary.

NEPHTHYS CÆCA (*Fabricius*). Several large specimens from Bullhill Bank (sta. 9).

NEPHTHYS HOMBERGII, *Audouin et Edwards.* As at Salcombe, this species was commonly found in sand and muddy sand all over the estuary. Where the ground became very muddy it disappeared.

NEPHTHYS CIRROSA, *Ehlers*, was found in considerable numbers on grounds where the soil was fine clean sand, but did not occur in any other localities. It appears to be only able to flourish in ground of this nature, and is therefore much more restricted in distribution than *Nephthys Hombergii. Nephthys cirrosa* was common on Polesands, on the sand of Bullhill Bank (sta. 9), and on the sand above Starcross (sta. 5); and one specimen is recorded from Cocklesand (sta. 13).

GLYCERA CONVOLUTA, *Keferstein*, was occasionally found on Bullhill Bank (sta. 9) and on the gravel between Powderham and Starcross (sta. 4).

PHYLLODOCE (*? maculata, Linn.*). A Phyllodoce, which appears to be referable to this species as described by Johnston (*British Museum Catalogue*, 1865), was taken on the sandy ground between Starcross and Cockwood (sta. 8).

PHYLLODOCE TERES, *Malmgren.* Found in fine clean sand on two grounds in the upper part of the estuary, viz. the sand bank above Starcross (sta. 5) and the sand west of Salthouse Lake (sta. 10). It is also recorded from the gravel between Powderham and Starcross (sta. 4), though the exact nature of the ground where the two specimens were taken was not noted. I found this species also at Teignmouth in clean sand, which appears to be its normal habitat (cf. Malmgren, *Nordiska Hafs. Annulater*, 1865, p. 97).

ETEONE PUSILLA, *Oersted* (nec *Malmgren*), was found several times at Exmouth in clean fine sand, generally in the same kind of soil as *Phyllodoce teres* (stations 5, 8, and 10). I also found it at Teignmouth under similar circumstances. The specimens agree with Oersted's original description (*Ann. Dan. Conspec.*, 1843, p. 30), "papillis caudalibus subglobosis," and not with Malmgren's figure and description (*Nord. Hafs. Ann.*, 1865, p. 102 and Tab. XV. Fig. 37), "cirri anales lineare-fusiformes elongati." The head also resembles Oersted's figure rather than that figured by Malmgren.

EULALIA VIRIDIS, *Müller*. Two specimens, from Orcombe Rocks, at the mouth of the estuary.

AUDOUINIA TENTACULATA, *Montagu*. One specimen only, from Orcombe Rocks. The entire absence of this species from the estuary itself is noteworthy.

HETEROMASTUS FILIFORMIS, *Claparède*. A few specimens of this species were taken in the sand west of Salthouse Lake (sta. 10).

PYGOSPIO SETICORNIS (*Oersted*) and PYGOSPIO ELEGANS, *Claparède*. (*Vide* Mesnil, "Études de Morphologie externe chez les Annélides," *Bull. Sci. France et Belge*, xxx., 1897, p. 85.)

The distinction between these two species depends almost entirely upon the presence or absence of a pair of branchiæ on the second setigerous segment, these branchiæ being present in *P. seticornis* and absent in *P. elegans*. As, however, these branchiæ seem often to be lost in preserved specimens, the distinction between the two species cannot be satisfactorily made with such material. Unfortunately I was unacquainted with Mesnil's paper on the subject at the time when the specimens were obtained, and as in the preserved collections specimens from the same locality sometimes showed and sometimes did not show the branchiæ in question, I have in the lists included all under the name *P. seticornis*, though I have some reason to think that both species are represented in the estuary.

The tubes of *Pygospio* were abundant in the clean hard sand of the estuary (stations 5, 8, 9, 10, and 13), but were not seen in the hard sand at Polesands, where the conditions are marine.

NERINE CONIOCEPHALA, *Johnston*. This species is closely allied to, if not identical with, *N. foliosa*, Aud. et Edw. The Exmouth specimens agree with Johnston's description in having the front of the head bluntly conical and pointed, not rounded as described by Cunningham and Ramage (*Trans. Roy. Soc. Edinb.*, 1888) for *N. coniocephala*, and by de St.-Joseph and Mesnil for *N. foliosa*. The anus is not surrounded by cirri.

Several specimens were obtained in the sand west of Salthouse Lake (sta. 10) and in the hard clayey mud to the north of it (sta. 11).

NERINE CIRRATULUS (*Delle Chiaje*). Specimens were found on Bullhill Bank and Cocklesand.

SCOLOPLOS ARMIGER, *O. F. Müller*, was not uncommon in sand on all the banks in the upper part of the estuary, but was not found on the Polesands.

ARICIA LATREILLII, *Audouin et Edwards*, was moderately plentiful in the hard sand on the south of the Polesands. The specimens were here very large. One small specimen, probably belonging to the same species, was found in the sand between Starcross and Cockwood (sta. 8).

ARENICOLA MARINA, *Linn.*, was very abundant in all the sand and gravel in the estuary itself, but only one specimen is recorded from the Polesands. One only was obtained from the mud at Greenlands (sta. 1). The species was most abundant in the fine clean sand, becoming less plentiful in coarse ground. It was noticed that in ground where *Arenicola* became less plentiful the Terebellid *Lanice conchilega* became more abundant, and *vice versâ.*

No other species of *Arenicola* was found.

CLYMENIDS, probably belonging to two species of the genus *Praxilla*, were found in the sand west of Salthouse Lake (sta. 10). One small one was taken in the sand between Starcross and Cockwood (sta. 8).

OPHELIA BICORNIS, *Savigny* (*vide* de St.-Joseph, *Ann. Sci. Nat.*, v., 1898, p. 380). The sand on the north-eastern side of the Polesands, that is, the side nearest to the main channel of the estuary, is somewhat coarse and loose. The only animal found living in it was *Ophelia bicornis*, but this worm was present in great numbers. It was only necessary to dig into the sand with the hand, when one or two specimens would be exposed. It was also found in moderate numbers in sand of a somewhat similar nature on the highest part of Bullhill Bank, that is, the portion first uncovered on the fall of the tide. Single specimens of the species were met with on the north side of the Warren (sta. 12), in the sand below Lympstone mussel beds (sta. 6), and in the Cocklesand (sta. 13).

POLYMNIA NEBULOSA, *Montagu.* A few specimens from the dock, and from dredging material from the sponge ground below the pier (sta. 14B).

LANICE CONCHILEGA (*Pallas*) was very common on the banks in the estuary, where there was a large proportion of gravel mixed with clean sand. It was particularly abundant on the north side of the Warren (sta. 12), between Cockwood and Starcross (sta. 8), between Starcross and Powderham (sta. 4), on all which grounds the soil was of the nature described. It was met with in smaller quantity on the banks where the soil was fine sand, *e.g.* Bullhill Bank (sta. 9), Cocklesand (sta. 13), and between Cockwood and Salthouse (sta. 10). It was not seen on the Polesands. This distribution is interesting when compared with the distribution at Salcombe, where the species occurred in great quantity on the fine clean sands near the mouth of the harbour.

As already pointed out under *Arenicola marina,* the latter species was very abundant on the fine clean sand banks where *Lanice* was not plentiful, whilst as the ground became coarser *Lanice* became abundant and *Arenicola* scarcer.

SABELLARIA ALVEOLATA, *Linn.* This worm was very common at Orcombe Rocks at the mouth of the estuary, forming the usual reef-like masses.

MELINNA ADRIATICA, *von Marenzeller.* One or two specimens only were found at each of the following localities: the Gravel between Powderham and Starcross (sta. 4), between Starcross and Cockwood (sta. 8), and on the sand west of the mouth of the Salthouse Lake (sta. 10).

The scarcity of this species in the estuary is noteworthy, as in the upper parts of the Salcombe estuary it occurred in enormous profusion in the mud-flats, especially in the very fine and soft mud. On the mud-flat at Greenlands, the highest part of the Exe estuary examined, and where the mud was in places very soft, not a single specimen was taken.

POMATOCEROS TRIQUETER (*Linn.*). Found only at Orcombe Rocks, at the mouth of the estuary.

CRUSTACEA.*

DECAPODA.

[Nomenclature: BELL, *Stalk-eyed Crustacea.*]

STENORHYNCHUS PHALANGIUM (*Pennant*). Three from Bullhill Deep Pit, one between Cocklesand and Bullhill Bank (sta. 13), one from Mere Bay (sta. 15), and four outside Polesands, all with mosquito net trawl.

CANCER PAGURUS, *Linnæus.* Small ones not uncommon among Orcombe Rocks; one small one dredged on the sponge ground off the Clock Tower (sta. 14B), and a few small ones in the dock.

CARCINUS MÆNAS (*Pennant*). Taken in almost every haul with the mosquito net trawl. Collected on Polesands and on most of the grounds above the Warren and in the dock.

PORTUMNUS VARIEGATUS, *Leach.* About half a dozen were found on the smooth sand on the west side of Polesands, buried an inch or two below the surface. After the flood-tide has started they seem to burrow a foot or so, generally in a direction towards the incoming tide, keeping just below the surface of the sand, and leaving a line of zigzag indentations on the surface, with a larger indentation at the end from which they started. One female was found in berry, July 3rd, 1901. One living specimen had a fairly large tuft of a green filamentous alga growing on the rostrum. Large numbers of cast shells were found on Polesands on July 17th, 1901.

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* By R. A. TODD.

PORTUNUS PUBER (*Linnæus*). Not uncommon in the dock and at Orcombe Rocks.

PORTUNUS DEPURATOR, *Leach*. One taken in mosquito net trawl outside Polesands.

PORTUNUS HOLSATUS, *Fabricius*. Two or three living specimens were found buried in the sand on Polesands.

CORYSTES CASSIVELAUNUS (*Pennant*). A female with ova found buried in sand on Polesands, July 17th, 1901.

PAGURUS (EUPAGURUS) BERNHARDUS (*Linnæus*). A few small ones on Bullhill Bank (gravel), one or two between Bullhill Bank and Cocklesand, one from Polesands, one in the dock, the latter with *Hydractinia*: small ones fairly common on Orcombe Rocks.

PORCELLANA PLATYCHELES (*Pennant*). Common under stones and in crevices at Orcombe Rocks, and one dredged on the sponge ground off Clock Tower (sta. 14B).

HOMARUS VULGARIS, *M.-Edwards*. Not uncommon in holes in the dock walls. They are caught by being enticed out with bait and speared.

CRANGON VULGARIS, *Fabricius*. Small and medium-sized shrimps were more or less abundant on all the sand- and mud-flats; large ones were only taken outside Polesands, on the Bar, and at Straight Point.

HIPPOLYTE (VIRBIUS) VARIANS, *Leach*. A few small ones were taken with the mosquito net trawl in Bullhill Deep Pit, two between Bullhill Bank and Cocklesand, and one on the Bar, all of a bright green colour.

PALÆMON SERRATUS (*Pennant*). One or two only from Bullhill Deep Pit, the channel between Bullhill Bank and Cocklesand, Mere Bay, and Kingslake. Common in the dock and at Straight Point, the latter being the locality where they, as well as shrimps, are taken for sale.

GASTROSACCUS SPINIFER (*Goës*). Nine were taken with the mosquito net trawl on the gravel on the west side of Bullhill Bank.

LEPTOMYSIS MEDITERRANEA, *G. O. Sars*. Two taken off the Polesands in 2–3 fathoms.

LEPTOMYSIS LINGURA, *G. O. Sars*. One taken off the Polesands in 2–3 fathoms.

MACROMYSIS FLEXUOSA, *Müller*. Taken everywhere in more or less abundance when using the mosquito net trawl. Common in the dock.

SCHISTOMYSIS PARKERI, *A. M. Norman*. One taken between Pole and Monster Sands.

SCHISTOMYSIS HELLERI, *G. O. Sars*. More or less common everywhere inside the estuary with *M. flexuosa*. One taken in the dock.

We are indebted to Mr. W. I. Beaumont for the following note on this species:—

"The specimens of *Schistomysis Helleri* from Exmouth, while agreeing generally with the descriptions of Sars and Norman, and with the figures of the first-named author, apparently fail to conform to the type in certain particulars, as did those found at Salcombe last summer. In the half-dozen adult specimens examined (males and females, from 9 to 13 mm. in length, inclusive of antennal scales and uropods), the number of spines on the margin of the inner uropods varied from twelve to sixteen, while an immature example of 8 mm. had already nine and ten spines respectively on those appendages; and in all the difference in length between inner and outer uropods is less marked than in the type. A further want of agreement with the published descriptions concerns the last pair of pereiopods, which in Exmouth examples cannot be strictly described as 'rudimentary,' or as being 'about half the length of preceding pairs.' In point of fact they are very much shorter than some of the anterior pairs, but the decrease in size is exhibited gradually in successive pairs; and, moreover, a nail is present, though small."

NEOMYSIS VULGARIS (*J. V. Thompson*). A few taken on the sand bank east of Powderham mussel beds (sta. 2).

ISOPODA.

[Nomenclature: G. O. SARS, *Crustacea of Norway*, vol. ii.]

GNATHIA MAXILLARIS (*Montagu*). A few taken in crevices at Orcombe Rocks.

IDOTHEA BALTHICA (*Pallas*). A few were taken at each of the following localities: South of Polesands, sand bank off Starcross, Bullhill Bank, the Bar, Cocklesand, and Orcombe Rocks.

IDOTHEA LINEARIS. One or two were taken on the Bar, south of Polesands, and on Bullhill Bank.

LIGIA OCEANICA (*Linnæus*). Common on the dock walls, above water-level.

SPHÆROMA SERRATUM. Fairly common on gravel on Bullhill Bank.

BOPYRUS SQUILLARUM. Two on *Palæmon serratus* from the dock.

AMPHIPODA.

[Nomenclature: G. O. SARS, *Crustacea of Norway*, vol. i.]

TALITRUS LOCUSTA (*Pallas*). Very common under weed at high-water mark south of Cocklesand and on the north side of the Warren (sta. 12). Not uncommon burrowing in the sand at Cocklesand.

BATHYPOREIA PELAGICA, *Sp. Bate.* Twenty in mosquito net trawl on sand bank off Starcross, one on Bullhill Bank, three between Cockwood and Bullhill Bank.

HAUSTORIUS ARENARIUS (*Slabber*). Not uncommon in the smooth sand west of Polesands. One in Shaggles Sand (sta. 5) and one in clean sand on north side of Warren (sta. 12).

SYNCHELIDIUM SP. One taken on Bullhill Bank.

PARATYLUS SWAMMERDAMI (*M.-Edwards*). A few were taken at each of the following localities: Between Pole and Monster Sands, south of Polesands, between Bullhill Bank and Cocklesand, and on the Bar.

DEXAMINE SPINOSA (*Montagu*). A few were taken among weeds on a boat in the dock, and on the sponge ground off the Clock Tower (sta. 14B).

GAMMARUS LOCUSTA, *Linnæus.* More or less common in nearly all hauls with the mosquito net trawl.

MELITA PALMATA (*Montagu*). One was taken with the mosquito net trawl on Bullhill Bank gravel.

AMPHITHOE RUBRICATA (*Montagu*). One dredged on sponge ground off the Clock Tower (sta. 14B).

AORA GRACILIS, *Sp. Bate.* Two from sponge ground off the Clock Tower (sta. 14B).

COROPHIUM GROSSIPES, *Linnæus.* Common burrowing in the muddy sand north of Salthouse Lake (sta. 11).

CIRRIPEDIA.

SACCULINA CARCINI (*J. V. Thompson*). Two on *Carcinus* from the Bar.

COPEPODA.

NOTOPTEROPHORUS (DOROPYGUS) GIBBER (*Thorell*). Common in the pharyngeal cavity of *Ciona intestinalis* in the dock. The specimens were identified by Mr. R. Gurney.

INSECTA.

COLEOPTERA.

HETEROCERUS FEMORALIS (*Kies*). Very common burrowing in fine loose sand on Cocklesand. Fowler (*Coleoptera of the British Isles*, vol. iii. p. 385) gives its habitat as "Banks of ponds and ditches; not common; Sheerness, Gravesend, Deal, Hastings, Brighton, Weymouth, Exmouth, Wales, Hunstanton, Cleethorps, Manchester, Prestonmarsh (Lancs.), Lancaster; Scotland, local, Solway and Forth districts; Baldoyle (Ireland). Species said to be chiefly maritime." The specimens were identified by Dr. Sharp.

MOLLUSCA.*

[Nomenclature: JEFFREYS, *British Conchology.*]

ANOMIA EPHIPPIUM, *Linnæus*. Three small ones were taken on the Polesands, adhering to a shell of *Trochus magus*, and one on the dock wall underneath the stage.

OSTRÆA EDULIS, *Linnæus*. Three were found on the gravel south-west of Starcross Pier (sta. 7) and a few shells on Polesands. There is no oyster fishery in the Exe.

PECTEN OPERCULARIS (*Linnæus*). On Polesands, shells only.

PECTEN MAXIMUS (*Linnæus*). On Polesands, shells only.

MYTILUS EDULIS, *Linnæus*. Stray mussels were to be found everywhere in the estuary, the centre of distribution being a mussel bank which extends from Checkstone Ledge along the channel nearly to the mouth of the harbour. This bed is composed chiefly of mussels, mussel shells, and pebbles held together by the threads of the byssus of the mussel, thus forming a compact mass. The mussel fishermen, of whom there are about fifty belonging to Lympstone, Powderham, and Starcross, collect the mussels at low water, when they are only covered by two or three fathoms. The instrument used is a rake fixed to a pole 20–25 feet long, and having a wire-net bag attached behind it. The boat is moored by a kedge, and the mussels simply raked up from the bottom. When a sufficient number are caught they are taken up the river and laid on the mussel beds, which are on sand banks off Lympstone, Powderham, and Starcross, the Lympstone bed being much the largest. The mussels remain on these beds two to three years, by which time they are of a marketable size. They are then collected, washed, and sold either as bait or for food. The mussel beds are sometimes troubled by a large growth of weed, chiefly *Ulva* and *Enteromorpha*, which is kept down by winkles (*Littorina*

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* By R. A. TODD.

littorea) and by hand picking. If this weed be allowed to grow, large numbers of mussels die from suffocation, as the weed causes the sand to silt up over them. This year (1901) the beds have suffered considerably from this cause, probably on account of the large amount of sunshine during the summer. The young mussels, about 1 mm. long, were extremely abundant on the *Enteromorpha* on Bullhill Bank (July 4th, 1901), on weed from the sponge ground off the Clock Tower (July 9th, 1901), and at Orcombe Rocks (August 17th, 1901). A single filament of *Enteromorpha* formed a resting-place for a hundred or more young mussels.

KELLIA SUBORBICULARIS (*Montagu*). One was taken in a crevice at Orcombe Rocks.

DIPLODONTA ROTUNDATA (*Montagu*). One or two shells were taken on Polesands, probably washed up from outside. It seems probable that this species burrows very deeply in the sand, as we have never yet taken it alive, although shells are not uncommon in places.

CARDIUM ACULEATUM, *Linnæus*. One valve of this species was found on Polesands.

CARDIUM ECHINATUM, *Linnæus*. Three small living specimens and many shells were taken on Polesands, the living ones being found just below the surface.

CARDIUM EDULE, *Linnæus*. Occurs in profusion on Cocklesand, Bullhill Bank, and all along the west side of the estuary, from the Warren upwards, wherever the ground is suitable. It is found either on the surface or buried just below, and its collection for sale gives employment to a fair number of men and women, who are generally to be seen at low tide armed with a "cock-rake," which is very like an ordinary garden hoe, and a basket. The ground is simply raked over, so that about half an inch to one inch of the surface is removed, and the cockles which are uncovered are then picked up.

CARDIUM NORVEGICUM, *Spengler*. Two living ones were obtained on the Polesands, lying on the surface of the sand. They were probably washed up from deeper water, the normal habitat of *C. norvegicum*.

VENUS CHIONE, *Linnæus*. Valves only of this species were found on the Polesands.

VENUS STRIATULA, *Linnæus*. One living one on the Polesands buried just below the surface.

TAPES VIRGINEA (*Linnæus*). One very small one dredged on the sponge ground off the Clock Tower (sta. 14B).

TAPES PULLASTRA (*Montagu*). A few shells only, on gravel between Cockwood and Starcross (sta. 17).

TAPES DECUSSATA (*Linnæus*). Living specimens were moderately common lying on the surface of the gravel on the north side of the Warren and east of the stream draining Greenland Lake (sta. 12). A few on gravel on Bullhill Bank and on coarse ground on Cocklesand.

TELLINA BALTHICA, *Linnæus*. Common on the mud-flats between Cocklesand and the L. and S. W. Station; a few on mud south of Lympstone mussel bed, and one or two on the west bank of the estuary between the Warren and Powderham. Nearly all the specimens obtained were lying on the surface of the mud, only one having been obtained by digging. They appear to be very shy animals, as we never saw one expanded, although they were kept alive for two or three days before preserving.

TELLINA TENUIS, *Da Costa*. This bivalve was very common on the west side of Polesands at low-water mark; moderately common on the fine sand between Cocklesand and Lympstone mussel beds, and a few were also taken on Bullhill Bank, the Warren, and Shaggles Sand. They were generally found buried two or three inches below the surface of the sand. On Polesands, where they were most common, three or four would be turned up in one spadeful of sand.

Tellina tenuis was always found on sand and *T. balthica* on mud.

DONAX VITTATUS (*Da Costa*). This mollusc was very common on the smooth banks of fine sand running off the west side of Polesands. Almost every specimen had a tuft of fine green weed or *Enteromorpha* (occasional) attached to the posterior (short) end of the shell. The animal being buried only just below the surface with the posterior end uppermost, the tuft of weed was always visible either waving in the water or lying on the sand, thus marking the position of the shell. A few of the living shells had hydroids growing on them, in addition to the weed, the hydroid being in three cases *Perigonimus repens*.

MACTRA SOLIDA, *Linnæus*. Not uncommon on Polesands in the same situation as *Donax vittatus*. When first uncovered by the tide they were generally found buried just below the surface, but after a time they emerged from the sand and lay uncovered until the tide rose again.

MACTRA STULTORUM, *Linnæus*. A few shells only of this bivalve were found on Polesands.

LUTRARIA ELLIPTICA, *Lamarck*. Shells only on Polesands.

SCROBICULARIA PIPERATA (*Linnæus*). One of the commonest bivalves of the Exe estuary; it was almost always present where the ground was composed of fine stiff mud. It occurred in profusion on Greenlands (sta. 1), on the mud inside Cocklesand (sta. 13), near Salthouse Lake (sta. 11), and all along the west bank, where the ground was suitable. It was generally found buried three to six inches below the surface, with which its burrow was connected by two, occasionally three narrow passages, which allowed the protrusion of the siphons. The siphons are in large specimens as much as six or seven inches in length.

SOLEN ENSIS, *Linnæus.* Not uncommon in the smooth sand on the west side of Polesands. This and the succeeding species (*S. siliqua*) when uncovered by the tide very often emerge from the sand and lie on the surface until the tide covers them again.

SOLEN SILIQUA, *Linnæus.* This fine Solen was not uncommon on Polesands in the same situation as *S. ensis.*

SOLEN VAGINA, *Linnæus.* Moderately common on a patch of firm, muddy sand on the west side of the mouth of Salthouse Lake (sta. 10). One from sand on Bullhill Bank (sta. 9).

SAXICAVA RUGOSA, *Linnæus.* Common boring in Orcombe Rocks.

PHOLAS DACTYLUS, *Linnæus.* Borings common in Orcombe Rocks. Only one specimen was obtained.

PHOLAS PARVA, *Pennant.* Borings common in Orcombe Rocks. One specimen was taken.

PATELLA VULGATA, *Linnæus.* Very common on Orcombe Rocks; not uncommon on stones between Cockwood and Starcross (sta. 8).

TROCHUS MAGUS, *Linnæus.* Shell only, inhabited by hermit-crab, from Polesands.

TROCHUS CINERARIUS, *Linnæus.* A few living ones from rough ground on north side of Warren (sta. 12); shells from Orcombe Rocks.

TROCHUS UMBILICATUS (*Montagu*). One living one from Polesands.

LITTORINA LITTOREA (*Linnæus*). Found in profusion on Cocklesand, Bullhill Bank, and Greenlands; not uncommon on the west bank. They are collected by boys, who sell them to the mussel-bed proprietors for the purpose of keeping the beds clear from weed.

RISSOA PARVA (*Da Costa*). One from Orcombe Rocks and one dredged off the Clock Tower on the sponge ground (sta. 14B).

HYDROBIA ULVÆ (*Pennant*). Occurred practically on all the sandy and muddy grounds where there was *Ulva*, *Enteromorpha*, or *Zostera*, notably on Greenlands (sta. 1) and the muddy ground with weed inside Cocklesand (sta. 13). When left on a bare patch of sand by the receding tide they burrow to a depth of one-eighth of an inch, probably in order to protect themselves from the sun.

TURRITELLA TEREBRA, *Linnæus.* A shell only, from Polesands.

NATICA CATENA (*Da Costa*). A dozen or so were found on the smooth sand of Polesands, burrowing just below the surface.

PURPURA LAPILLUS (*Linnæus*). Very common at Orcombe Rocks; a few shells and one alive from Polesands.

BUCCINUM UNDATUM, *Linnæus.* Shells only, Orcombe Rocks and Polesands. One small living one on mussel bank (sta. 14C), and three dredged off the pier (sta. 14A).

CYPRÆA EUROPÆA, *Montagu.* A few alive from Orcombe Rocks; shells from Polesands.

APLYSIA PUNCTATA, *Cuvier.* Spawn only of this species was taken in the mosquito net trawl, between Bullhill Bank and Cocklesand.

ELYSIA VIRIDIS, *Montagu.* Three from Bullhill Deep Pit (sta. 9), and one or two from Engineering Company's stage in the dock.

DORIS TUBERCULATA (*Cuvier*). One specimen is recorded from Bullhill Bank by Mr. Holt, in May, 1897.

ANTIOPA CRISTATA, *Delle Chiaje.* Several on the walls and piles of the dock, and one from the bottom of the *Dawn.*

SEPIOLA ATLANTICA, *D'Orbigny.* One taken in shrimp trawl on Shaggles Sand (sta. 5).

POLYZOA.

[Nomenclature: HINCKS, *British Marine Polyzoa.*]

SCRUPOCELLARIA SCRUPOSA (*Linnæus*). A few colonies dredged on the sponge ground off the Clock Tower (sta. 14B).

BUGULA TURBINATA, *Alder.* Common in the dock on the piles, old boats, etc., and at Orcombe Rocks.

MEMBRANIPORA MEMBRANACEA (*Linnæus*). Common on Laminaria at Orcombe Rocks.

LOXOSOMA PHASCOLOSOMATUM, *Vogt.* Not uncommon on the posterior end of *Phascolosoma vulgare*, from the north side of the Warren (sta. 12).

TUNICATA.

[Nomenclature: HERDMAN, *A Revised Classification of the Tunicata,* Jour. Linn. Soc. Zool., xxiii.]

ASCIDIELLA ASPERSA (*O. F. Müller*). Common, growing on piles, boats, etc., in the dock. They seem to grow very rapidly, as specimens an inch long were found on the bottom of the ss. *Oithona* nine weeks after she had been scraped and painted, and of about the same size on the bottom of the *Dawn* after two months in Exmouth Dock.

CIONA INTESTINALIS (*Linnæus*). This Ascidian was found in great profusion in Exmouth Dock on the piles and wall under the Engineering Company's stage, and also on the wall just inside the dock gates, some of the specimens being eight or nine inches in length. Smaller ones were common on the bottom of boats which had been lying in the dock for some time. One on the *Dawn*, after she had been lying there two months, was four or five inches long. Whether the dock is a regular habitat of *Ciona* we cannot say, not having any previous records, but at Plymouth this year the same species is extremely abundant in Millbay Docks, some of the specimens being as much as a foot long, whereas formerly we have never found more than a few small ones each year. Many of the Exmouth specimens were infested with a large species of Copepod, *Notopterophorus gibber*.

PISCES.*

[Nomenclature: DAY, *British Fishes.*]

LABRAX LUPUS (*Lacépède*). Caught in the estuary by hook and line and by seine. Between the Warren and Cockwood, seine, April 7th, 1897, one, 13 cm.; May 29th, 1897, one 8 cm., one 12 cm. [E.W. L. HOLT.]

COTTUS BUBALIS, *Euphrasen*. Four were taken between Bullhill Bank and Cocklesand, measuring respectively 4, 4·6, 10·2, and 11·7 cm. Off Bullhill Bank, off the Warren (north side), and Mere Bay, April and May, 1897. [E. W. L. H.]

TRIGLA HIRUNDO, *Linnæus*. Five, 14–23 cm., caught with seine off Bullhill Bank, May, 1897. [E. W. L. H.]

AGONUS CATAPHRACTUS (*Linnæus*). One taken between Pole and Monster Sands and one on sand bank off Starcross; 4·8 cm. and 4·4 cm. respectively. Off the north side of the Warren and Bullhill Bank, April and May, 1897. [E. W. L. H.]

TRACHINUS VIPERA, *Cuv. and Val.* A "sting-fish," probably this species, was taken by professional seiners off Polesands. The specimen was not examined. Two off Bullhill Bank, May, 1897. [E. W. L. H.]

GOBIUS RUTHENSPARRI, *Euphrasen*. Fairly common among the piles in Exmouth Dock, especially under the stage. One taken in a hand net measured 5·3 cm.

GOBIUS PAGANELLUS, *Gmel.* Several taken in the dock in a prawn-pot, 5·8 to 10·1 cm. in length.

GOBIUS MINUTUS, *Gmel.* This is by far the commonest Goby of the estuary; it was present in almost every haul of the mosquito net trawl taken above the Warren, varying in length from 1·2 to 5·7 cm. A batch of eggs found in a shell on Bullhill Bank, July 4th, 1901, hatched out the same day, the newly hatched young being about 2·4 mm. in length.

CALLIONYMUS LYRA, *Linnæus*. One off the north side of the Warren and one off Bullhill Bank with seine, May, 1897. [E. W. L. H.]

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* By R. A. TODD.

BLENNIUS PHOLIS, *Linnæus.* Most common at Orcombe Rocks and among the piles and in crevices in the walls of the dock. Two were also taken in Mere Bay and one on Bullhill Bank.

ATHERINA PRESBYTER, *Jenyns.* A large shoal of very young Atherines was seen in the dock on August 16th, 1901. Those which were caught were ·7 to 1·1 cm. in length. No large ones were seen. The specimens were identified by Dr. Kyle.

MUGIL CHELO, *Cuvier.* Shoals of large grey mullet were almost always to be seen in the dock, generally under the boats which had been in the dock some time, and were therefore covered with weed, etc. A shoal of young ones was seen in the dock on August 16th, 1901, and about twenty were caught, measuring from 2·5 to 2·7 cm. Common in the dock, May, 1897 [E. W. L. H.] Grey mullet are also caught in the estuary, generally in seines.

GASTEROSTEUS ACULEATUS, *Linnæus.* One "three-spined stickleback" was caught in the dock, with the young grey mullet mentioned above, 2·5 cm. in length.

GASTEROSTEUS SPINACHIA, *Linnæus.* Single specimens were taken with the mosquito net trawl at each of the following localities: Bullhill Bank, Mere Bay, and between Pole and Monster Sands. Two off north side of Warren, in the seine, April, 1897. [E. W. L. H.]

LABRUS MACULATUS, *Blainville.* Between Bullhill Bank and Cocklesand, two of 2·0 and 2·5 cm.; Mere Bay, one of 2·2 cm., and Bullhill Deep Pit, five, 1·4 to 3·0 cm. in length; Exmouth Dock, one of 15 cm.

CRENILABRUS MELOPS (*Linnæus*). Small ones from 1 to 3 cm. long were moderately common in Bullhill Deep Pit, channel between Bullhill Bank and Cocklesand, and Mere Bay. Larger ones of about 7 cm. and upwards were not uncommon in the dock, being frequently caught in a prawnpot.

GADUS POLLACHIUS, *Linnæus.* One, 4·0 cm. in length, was caught in the dock on July 9th, 1901.

AMMODYTES TOBIANUS, *Linnæus.* One of the commonest fish in the lower part of the Exe estuary. It was often to be seen going about in shoals containing several thousand fish of about the same size. In a shoal seen in the dock entrance on July 11th, 1901, five were caught from 4·5 to 5·5 cm. in length. I am indebted to Dr. Kyle for the identification of this species.

RHOMBUS MAXIMUS (*Linnæus*). One seined off north side of Warren, April 7th, 1897, 14 cm. long. [E. W. L. H.]

RHOMBUS LÆVIS, *Road.* Young brill were caught in the mosquito net trawl, etc., at the following localities: On the Polesands, one with fine-meshed seine; off Cockwood, on sand, one of 2·3 cm. (July 8th, 1901); in Salthouse Lake, July 18th, 1901, one of 3 cm., August 5th, 1901, two of 2·9 and 2·8 cm. respectively; Mere Bay, April, 1897, two of 18 cm. [E. W. L. H.]; off north side of Warren, April, 1897, one of 14 cm.; and two in May, 1897, of 17 and 21·5 cm. respectively. [E. W. L. H.]

PLEURONECTES PLATESSA, *Linnæus.* Young plaice were found to be very common in Salthouse Lake and along the shore above the mouth of the lake at low water, and were taken in some numbers in a shrimp net (shove net). Mr. Holt records a number of plaice obtained at Exmouth in 1897 with a seine net as used by the fishermen at Exmouth, and with a tuck net of the Saltash pattern belonging to the Laboratory.

The numbers and sizes (in inches) of fish obtained are recorded in the following tables:—

Plaice taken in Mere Bay by Mr. Holt with Professional Seine in April, 1897.

Size in inches.	Number.	Size.	Number.	Size.	Number.
2¾	1	5¼	8	9	1
3	2	5½	3	9½	1
3¼	3	5¾	3	11	1
3½	3	6	3	11½	1
3¾	4	6¼	1	11¾	1
4	8	6½	3	13	1
4¼	4	7	2	13½	1
4½	3	7¼	2	13¾	1
4¾	3	8	1	14	1
5	5	8¼	1	20	1

Plaice taken in the Bight north of the Warren by Mr. Holt with Professional Seine in April, 1897.

Size in inches.	Number.	Size.	Number.	Size.	Number.
2¼	1	4½	10	6¾	2
2½	10	4¾	4	7	2
2¾	31	5	2	7¼	1
3	38	5¼	6	7½	1
3¼	23	5½	12	8	1
3½	18	5¾	3	8½	1
3¾	15	6	3	9	1
4	19	6¼	5	10¾	1
4¼	14	6½	4	—	—

Plaice taken in the Bight north of the Warren by Mr. Holt with the Laboratory Tuck Net in May, 1897.

Size in inches.	Number.	Size.	Number.	Size.	Number.
1¼	3	4¼	21	6¾	2
1½	1	4½	14	7	2
1¾	2	4¾	7	7¼	4
2	3	5	10	7¾	2
2¼	2	5¼	8	8¼	1
3	3	5½	8	8½	1
3¼	14	5¾	6	8¾	1
3½	25	6	8	10¾	1
3¾	31	6¼	5	11	1
4	18	6½	3	11½	1

Plaice taken at Exmouth during July and August, 1901, almost wholly in Salthouse Lake, with Shove Net.

Size in inches.	Number.	Size.	Number.	Size.	Number.
1½	20	2¾	12	5½	4
1¾	40	3	2	5¾	1
2	29	3¼	1	6¼	1
2¼	17	3¾	1	—	—
2½	12	4½	2	—	—

PLEURONECTES LIMANDA, *Linnæus.* Off north side of the Warren, April and May, 1897, nine, 9–11·5 cm. Bullhill Bank, May, 1897, eleven, 9·5–12·5 cm. [E. W. L. H.]

PLEURONECTES FLESUS, *Linnæus.* Off the north side of the Warren, May, 1897, one of 13 cm. and one of 30·5 cm.; Bullhill Bank, April and May, 1897, five, 9·5–17 cm. [E. W. L. H.]

SALMO SALAR, *Linnæus.* There is a regular salmon fishery in the Exe estuary during the season, which gives employment to several large rowing boats, each of which is manned by four to six men and works one seine. The seine is about one hundred fathoms long and three to four fathoms deep in the middle, where there is a bag, and narrows to a fathom at each end, with a mesh of 4¼ inches. The net is shot across the stream, then towed down with the tide for two or three hundred yards and hauled. Each boat generally manages two and sometimes three hauls at low water.

BELONE VULGARIS (*Linnæus*). One was caught when seining for sand-eels (*Ammodytes*) off Polesands.

CLUPEA HARENGUS, *Linnæus.* Bullhill Bank, seine, April, 1897, two, 26 and 29 cm.; and north side of Warren, seine, April, 1897, six, 23·5–32·5 cm. [E. W. L. H.]

CLUPEA SPRATTUS, *Linnæus.* Bullhill Bank, seine, May, 1897, six of 5 cm.; and off north side of Warren, April, 1897, six, 5·5–7 cm. [E. W. L. H.]

ANGUILLA VULGARIS, *Turt.* Two small ones, about 20 cm. in length, were caught in the dock.

CONGER VULGARIS, *Cuvier.* One of about 4 lbs. weight was seen among the piles in the dock.

SYNGNATHUS ACUS, *Linnæus.* Two were taken in the mosquito net trawl on the sand bank off Starcross, and several in the shove net in Salthouse Lake. Two were taken off the north side of the Warren in the seine, April, 1897. [E. W. L. H.]

SYNGNATHUS ROSTELLATUS, *Nilss.* This species is easily distinguishable from *S. acus* of the same size by the number of pre-anal rings, which in *S. rostellatus* varies, in the specimens obtained at Exmouth, from 13 to 15; in *S. acus* they number 19–20 (see Duncker, *M.B.A. Journal*, N.S. vol. v. p. 175). Seven were taken in the mosquito net trawl on the Bar, from 5·8–11·5 cm.; seven, a quarter-mile south of Polesands, 5·9–14·9 cm.; two between Pole and Monster Sands, 7·4 and 13·8 cm.; a few in the dock and on Shaggles Sand; and four on the sand bank east of Powderham mussel beds, 12·3 to 15·7 cm. in length. The one measuring 15·7 was a male carrying embryos which hatched out on the same day (July 25th, 1901), the young fish measuring 14 mm. when hatched. The finrays and rings in the specimens from a quarter-mile south of Polesands (the only ones examined) were found to vary as follows: Pre-anal rings, 13–15; total number of rings, 52–56; dorsal finrays, 34–40; pectoral, 10–11, mostly 11; caudal rays, 10.

The Foraminifera of the Exe Estuary.

By

R. H. Worth.

SAMPLES of sand were taken, either from the shore immediately above low water of spring tides, or from the bottom in a few inches of water.

With one exception no samples were dredged. The localities were few: Polesands; the north or estuarine shore of the Warren west of Salthouse Lake; the banks of the Salthouse Lake; a low-water stream on the Warren; near Lympstone; and (the dredged sample) within Exmouth Docks.

To appreciate the results it is necessary to consider shortly the physical conditions at the mouth of the Exe estuary.

The low-water channel of the Exe, which would naturally enter the sea in a southerly direction, is diverted by a spit of land known as the Warren and a sand bank known as the Polesands, turned through a right angle to the eastward, and only after passing some little distance parallel to the coast discharges into the sea.

That portion of the Polesands which uncovers at low water is chiefly, if not entirely, pure sand; the surface is in no way compacted, but is unstable and ridges, furrows, and travels with every tide.

The Warren consists of sands, gravels, and shingles, with patches of fair-sized pebbles, and to the westward compact clays.

From the presence of these clays it may be surmised that the western end of the Warren is a genuine spit of land; the eastern end and the Polesands are alike due to littoral drift.

The mouth of the Exe is more exposed to southerly than to easterly gales, and breakers from the southward drift the beach across the estuary, and drift it in greater quantity than the tidal current of the ebb, setting out from the estuary, can remove in the intervals between successive gales.

Easterly gales, which are rare, and are to some extent fended off by the coast-line, have been unable to drive the sand and shingle back to their original postion westward and southward of the harbour mouth.

In course of time the limit has been reached at which the tidal scour of the ebb, and the breakers from the eastward, suffice to check the further easterly advance of the bar.

The channel between the Polesands and the land has adjusted itself to that width and depth through which the waters of the ebb will flow with sufficient velocity to maintain a fairly constant cross-section.

The surface of the Polesands, turned over by wave and current action even in calm weather, contains little or no organic matter, and any Foraminifera attempting to establish themselves thereon are liable on each tide to be buried at a considerable depth below the surface.

The average least diameter of the largest sand grains on the seaward slopes of the Polesands is 0·7 mm., the average least diameter of the largest sand grains on the estuarine slope of those sands is 0·4 mm.; in each case the average greatest diameter would be about 50 per cent. more. The figures were obtained by ranging a number of grains between parallel plates. The average least diameter of the largest sand grains at low-water mark on the north shore of the Warren is 0·25 mm.

To move a grain of quartz sand of 1 mm. diameter requires a current of velocity 0·5 feet per second, or, say, one-third of a knot; while to move a grain of 0·25 mm. requires a velocity of 0·25 feet per second, or, say, one-sixth of a knot.

If the sand is once allowed to compact thoroughly with a reasonable admixture of silt, a much higher velocity is required to move it, say, up to ten times the figures above given.

To anyone familiar with the actual tidal currents at Exmouth the unstable nature of the surface of many of the sand banks, especially below half-tide level, will be at once apparent.

According to King's *Channel Pilot*:—

> "When the banks at the entrance (of the estuary) are covered, both flood and ebb streams set fairly over them, about 2½ knots; but when uncovered, these streams run strong through the channel, and their strength increases at Ferry Point to 5 knots."

The channel followed by the ebb across the Polesands at the end of the Warren, until these sands are uncovered, can be clearly seen on the chart of the harbour.

It is to be noted that the grains on the inner side of the Polesands are much better polished and rounded than those on the outer. The former travel some little distance to and fro with each ebb and flood, the latter are chiefly subject to wave-action.

The Warren sand is richer in organic matter as it rises in level from low-water toward high-water level, but it is not to be understood that the increase in organic matter is directly proportioned to level.

Near Lympstone a very fine sand occurs, the average least diameter of the largest grains being only 0·12 mm.

The conditions being so unfavourable, it is not surprising that Foraminifera are scarce.

On the Polesands, above and immediately below low water, there are practically no living Foraminifera.

Stranded on the outer or seaward slopes of these sands the following dead shells were found; no attempt has been made to estimate the relative numbers.

Miliolina seminulum.
Truncatulina lobatula.
Rotalia beccarii.
Nonionina depressula.
Polystomella crispa.
Polystomella striato-punctata.

On the northern or estuarine slope of these sands even dead shells are absent.

The method of investigation adopted consisted in spreading 13 c.gms. of each sand on a glass slip and counting and identifying the Foraminifera.

This process is not exhaustive, as small specimens and species may be overlooked, no matter how carefully the sand may be spread. Also the less common species cannot be expected to be represented in each 13 c.gms. Accordingly fifty times this quantity (6·5 gms.) is taken, and the Foraminifera floated from same as far as may be. Invariably additional species are thus found. The drawback to this proceeding lies in the fact that the numerical results are no longer absolute. No doubt the direct count gives results in themselves too low, but at least fairly comparable as between the species identified. In floating, however, only a small proportion of the Foraminifera of any species are obtained, and the relative numbers of the different forms depend largely on the weight per unit displacement of the individual species. Thus *Rotalia beccarii* floats extremely ill, and *Polystomella striato-punctata* fairly well. The effect from actual averages is as follows: Assume a case in which 1,000 of each of the following species are counted in a sample, then on floating we should obtain the following numbers only:—*

	For each 1,000 found by actual count.		
Polystomella striato-punctata . . .	170	or 17	per cent.
Biloculina ringens	167	,, 16·7	,,
Planorbulina mediterranensis . .	73	,, 7·3	,,
Nonionina depressula	36	,, 3·6	,,
Bulimina pupoides	30	,, 3	,,
Miliolina seminulum	13	,, 1·3	,,

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* It should be noted that the figures given are the average of a large number of observations; but when, as at Exmouth, a great proportion of each species is represented by small individuals, the actual percentages which float will be much greater than given in the table, the relative percentages remaining constant.

	For each 1,000 found by actual count.		
Discorbina rosacea	12	or	1·2 per cent.
Truncatulina lobatula	10	,,	1 ,,
Textularia gramen	6	,,	0·6 ,,
Rotalia beccarii	1½	,,	0·15 ,,

It would therefore appear as though *Polystomella striato-punctata* were 113 times more numerous than *Rotalia beccarii*, although both would really be present in equal numbers.

Undoubtedly some of the *Lagena*, *Nodeosaria*, and *Bolivina* float better than *Polystomella*, but exact figures have not been ascertained; the above table is itself somewhat tentative. Meanwhile, numerical results from floating are still of value as giving the relative abundance of any one species in different samples.

SAMPLE taken just above low-water mark, on the north shore of the Warren, about 150 yards west of Salthouse Lake stream.

FORAMINIFERA COUNTED IN 13 C.GMS.	No.	Per cent.
Nonionina depressula	4	50
Polystomella striato-punctata	2	25
Miliolina seminulum	1	12½
Rotalia beccarii	1	12½
	8	100

FORAMINIFERA FLOATED FROM 6·5 GMS.	No.
Nonionina depressula	90
Polystomella striato-punctata	52
Lagena orbignyana	6
Miliolina seminulum	5
Rotalia beccarii	5
Polymorphina (?) *	3
Trochammina inflata	3
Polystomella arctica	3
Polystomella crispa	2
Nonionina stelligera	2
Bulimina pupoides	1
Bolivina	1
Spirillina (?)	1
Undetermined	2
	176

A SAMPLE taken at the same place but under low-water mark contained but few Foraminifera, and the results would only be possibly misleading.

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* Provisionally attributed to *Polymorphina*. This species will form the subject of further inquiry.

ANOTHER SAMPLE taken from inside an old kettle resting on sand at same point below low water yielded the following:—

FORAMINIFERA COUNTED IN 13 C.GMS.	No.	Per cent.
Nonionina depressula	5	45½
Polystomella striato-punctata	4	36½
Polystomella arctica	1	9
Rotalia beccarii	1	9
	11	100

The comparative shelter of the kettle probably accounts for the presence of these as against the practical absence of all Foraminifera from the sand on which the kettle rested.

A SAMPLE taken immediately above low water on the bank of the Salthouse Lake stream, about 100 yards from the low-water channel of the Exe.

FORAMINIFERA COUNTED IN 13 C.GMS.

This method was not applied in the present instance.

FORAMINIFERA FLOATED FROM 6·5 GMS.	No.
Polystomella striato-punctata	91
Nonionina (chiefly) depressula	49
Rotalia beccarii	3
Polymorphina (?) *	2
Miliolina seminulum	2
Trochammina inflata	1
Haplophragmium canariense	1
Lagena hexagona	1
Lagena orbignyana	1
Bulimina pupoides	1
Bolivina dilatata	1
Biloculina ringens (?)	1
	154

SAMPLE received labelled—"Lympstone mussel-bed, sand between weeds." This is a singularly fine sand and very free from silt.

FORAMINIFERA COUNTED IN 13 C.GMS.	No.	Per cent.
Rotalia beccarii	6	60
Nonionina depressula	3	30
Polystomella striato-punctata	1	10
	10	100

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* See previous footnote.

Foraminifera floated from 6·5 gms.	No.
Nonionina depressula	30
Polystomella striato-punctata	27
Lagena orbignyana	18
Rotalia beccarii	9
Miliolina seminulum	8
Polystomella arctica	2
Verneuilina polystropha	2
Undetermined	4
	100

Sample dredged from bottom of Exmouth Docks: consists of a fine sand mixed with much silt and organic matter; general appearance a somewhat sticky mud. In this case there is an entire absence of tidal scour or wind wash, and a constant depth of water. On the other hand, the water of the dock is by no means so clear or pure as in the channel outside the gates.

Foraminifera counted in 13 c.gms.

It was impossible to take a satisfactory census in this manner.

Foraminifera floated from 6·5 gms.	No.
Nonionina depressula	178
Polystomella striato-punctata	33
Rotalia beccarii	31
Lagena orbignyana	11
Miliolina seminulum	10
Bulimina pupoides	5
Verneuilina polystropha	2
Polymorphina compressa	2
Bolivina textilaroides	1
Bolivina dilatata	1
Cornuspira foliacea (?)	1
Undetermined	11
	286

From the relative floating capacity of the species it is obvious that *Rotalia beccarii* greatly predominates, and is followed by *Nonionina depressula.*

LIST OF SPECIES TAKEN.

[Nomenclature: BRADY, *Challenger Report*, ix.]

BILOCULINA RINGENS (*Lamarck*). One individual somewhat doubtfully identified, from Salthouse Lake.

MILIOLINA SEMINULUM (*Linn.*). Dead shells from the southern slope of the Polesands. One of the four or five commoner species from the Warren, Salthouse Lake, and Lympstone; and decidedly one of the more prominent on the bed of Exmouth Docks. Nowhere really plentiful, and no large, well-grown specimens obtained except from the south slope of the Polesands.

HAPLOPHRAGMIUM CANARIENSE (*d'Orbigny*). A single individual from Salthouse Lake.

TROCHAMMINA INFLATA (*Montagu*). At low-water mark on Warren and from Salthouse Lake. Well-grown specimens.

VERNEUILINA POLYSTROPHA (*Reuss*). Found at Lympstone and in Exmouth Docks. Appears in this estuary to replace the *Textularia*, no specimen of either *Textularia gramen, agglutinans*, or *saggitula* having been found.

BULIMINA PUPOIDES, *d'Orbigny*. Single individuals from Warren and Salthouse Lake; five times as plentiful in Exmouth Docks, which is not a typical ground for this species. Probably, however, *Bulimina*, in common with all the more elongate Foraminifera, suffers more than the lenticular forms from the tidal scour. The actual number present in the sample from the docks does not compare with the representation of this species on grounds where it is really at home.

BOLIVINA DILATATA, *Reuss*. Found at Warren, Salthouse Lake, and Exmouth Docks; in neither case more than barely represented. From some results not numerically stated above, is probably more plentiful in the docks than elsewhere.

BOLIVINA TEXTILAROIDES, *Reuss*. Exmouth Docks.

LAGENA HEXAGONA (*Williamson*). Salthouse Lake only, but may occur elsewhere; distinctly rare however.

LAGENA ORBIGNYANA (*Seguenza*). Six floated from 6·5 gms., Warren; one from 6·5 gms., Salthouse Lake; eighteen from similar quantity, Lympstone; and eleven from Exmouth Docks. A light shell of small size which succeeds here in establishing itself in comparatively quiet situations. Compared with its occasional numbers, it is poorly represented at all the stations mentioned above.

POLYMORPHINA COMPRESSA, *d'Orbigny*. Infrequent.

SPIRILLINA. One of doubtful species, from Warren.

CORNUSPIRA FOLIACEA (*Philippi*). A single individual somewhat doubtfully identified, from Exmouth Docks.

TRUNCATULINA LOBATULA (*Walker and Jacob*). Dead shells from south slope of Polesands; absent elsewhere. An adherent species; its absence is probably largely if not entirely due to the want of suitable hosts.

It may be noted that *Planorbulina mediterranensis*, another adherent species, is also absent.

ROTALIA BECCARII (*Linn.*). In all samples. Where the numbers are so small percentages are apt to be misleading. At the Warren and Salthouse Lake this species is third in point of number, *Nonionina* and *Polystomella* being distinctly more numerous.

In the sample from Lympstone *Rotalia beccarii* is distinctly the dominant species, as also in the dredging from Exmouth Docks.

NONIONINA DEPRESSULA (*Walker and Jacob*). All samples. The dominant species at Warren and the second at Lympstone, probably the second in Exmouth Docks. Distinctly an estuarine species, but is still fairly prominent in some localities at twenty fathoms off this coast.

NONIONINA STELLIGERA, *d'Orbigny*. Probably occurs in all samples; in much less number, however, than *depressula*.

POLYSTOMELLA CRISPA (*Linn.*) and

POLYSTOMELLA STRIATO-PUNCTATA (*Fichtel and Moll.*). These forms have been treated as separate species to this extent, that the individuals have been assigned to one or the other denomination according to a purely arbitrary judgment that the specimen more nearly approached the recognised type of *crispa* or *striato-punctata*.

Var. *striato-punctata* is distinctly the more prominent, and is second in order at the Warren, probably third in order at Salthouse Lake, third at Lympstone, and third in Exmouth Docks.

Well-charactered forms of var. *crispa* are rare, and extreme types absent.

POLYSTOMELLA ARCTICA, *Parker and Jones*. This seems another ill-defined species, which may apparently be regarded as of merely varietal significance.

The above list of species gives all the commoner forms, and some at least which are present in but small numbers; it cannot, however, be regarded as actually exhaustive.

Generally speaking, it indicates that the conditions are very distinctly more estuarine than at Salcombe.

A few dredgings from the low-water channels would have given a greater value to the results.

The Plankton of the Faröe Channel and Shetlands. Preliminary Notes on some Radiolaria and Copepoda.

By

R. Norris Wolfenden, M.D., Cantab., F.Z.S.

(With Plates I.–IV. and a Chart.)

In the year 1899 I commenced a series of tow-nettings round the coast of Shetland, and established four stations—one south of Sumburgh Head (III.), one west of Papa Stour (IV.), one of the northernmost points of Shetland (V.), and one due east of Bressay (VI.). During 1899 my yacht (the *Walwin*), a cutter of forty tons, made the round of these stations once a month during October, November, and December; and in 1900 during January, February, March, April, May, and June. During July, 1900, a passage was made across to Thorshaven (and back to Scalloway, Shetland), where stations were established, numbered respectively A1, A2, A3, A4, A5, A6, A7, A8, A9. (See Chart.) During August, 1900, only a short trip to the first two stations in the Faröe Channel was possible. In October, 1900, January, 1901, April, 1901, the stations round Shetland were visited again, and during May, 1901, a further passage was made to Thorshaven and back to Scalloway, visiting the stations previously fixed in the Faröe Channel. This passage was repeated in June, 1901, and again in July, 1901.

At each station round Shetland a surface haul was made with a fine silk net, followed by a vertical haul with an open net; and in February, 1901, I used for the first time a closing net supplied to me by the Plymouth Biological Station, and designed by my friend Mr. W. Garstang. This has subsequently been used on every occasion, both at the Shetland stations and on each trip to the Faröe Islands.

Thermometers were attached to the net, a reversing thermometer of Negretti and Zambra's pattern, supplied with Knudsen's bulb, and a Miller-Casella minimum thermometer; and the temperatures of each haul have been carefully recorded. In addition to these hauls a mid-water net of Professor McIntosh's pattern, supplied to me from St. Andrews, was used on every occasion where it was practicable. The procedure adopted has been as follows: At the Shetland stations

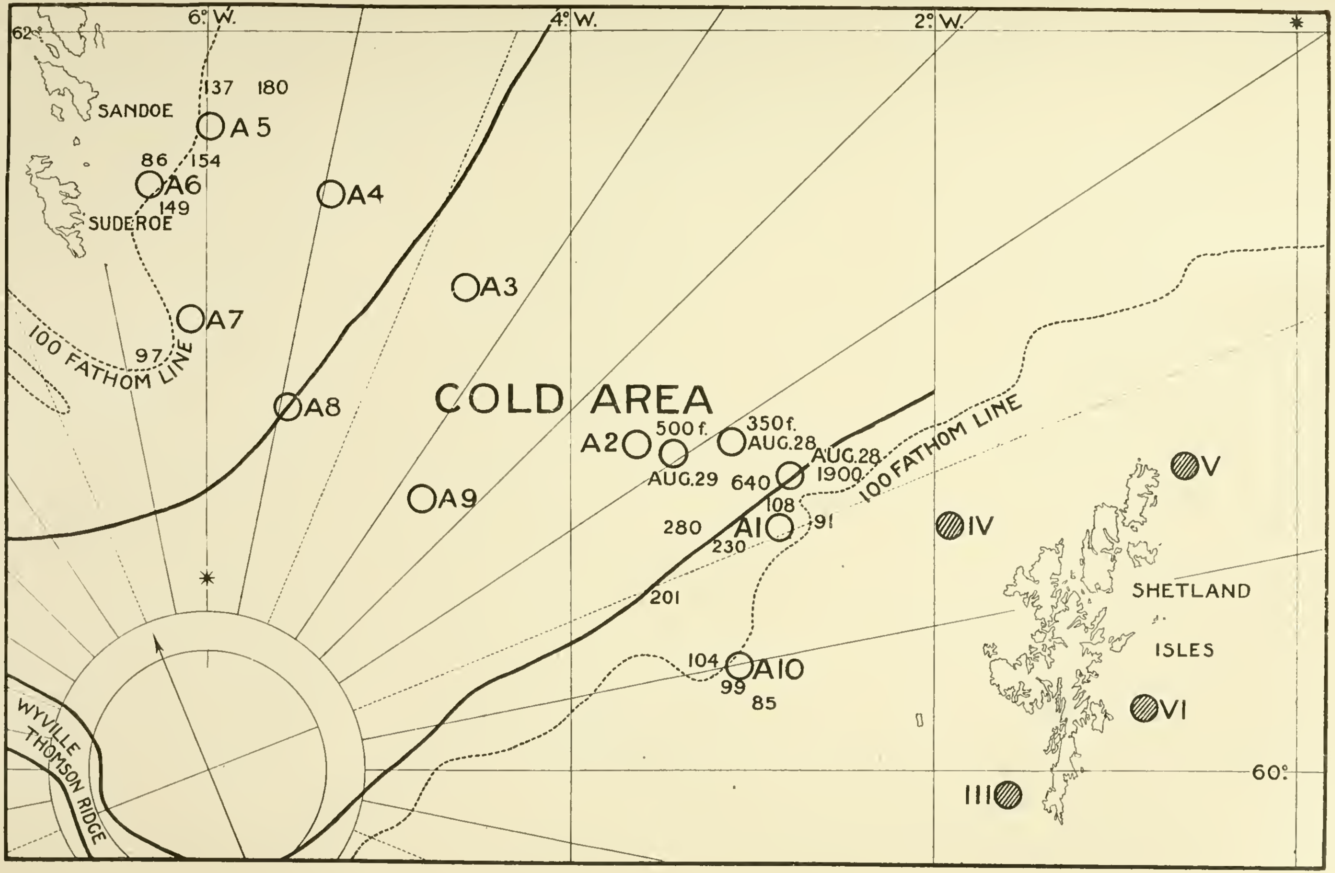
62°
6° W.
4° W.
2° W.
60°
SANDOE
SUDEROE
137
180
A 5
86
154
A6
149
A4
A3
A7
97
100 FATHOM LINE
A8
COLD AREA
A2
500 f.
AUG.29
350 f.
AUG.28
AUG.28
1900
640
100 FATHOM LINE
A9
108
A1
91
280
230
201
104
A10
99
85
V
IV
SHETLAND
ISLES
VI
III
WYVILLE THOMSON RIDGE

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Chart showing Stations at which Tow-nettings were taken in the Faröe Channel and round the Shetland Coast by Dr. Wolfenden.

To face page 344.

a sounding was first taken, then a surface haul, then a vertical haul with open net, and finally a haul from the deepest area with a closing net (Garstang's). Temperature records and water samples * of the area fished were taken, and the mid-water net was towed out behind the vessel while these observations were being made—sometimes (when in deep water) for as much as five hours at a station where much work had to be done. Once over the 100-fathom line, *i.e.* in the Faröe Channel, these procedures were repeated at each 100-fathoms depth down to 500 fathoms, with the omission of the vertical haul with open net, this being considered unnecessary. I have found Garstang's net perform very satisfactorily, and with a fine wire stand quite vertically in the sea. I am aware that objections are urged against a light net of this character in deep water, and Dr. Fowler used in the Faröe Channel a net and wire which, when weighted, exceeded some four times the weight of Garstang's net. I do not intend here to discuss the matter, but will merely remark that my own hauls in deep water agree very closely with those of Dr. Fowler, which were executed with every possible care to ensure accuracy. It is with satisfaction that I note this, and I cannot but think that some of the objections to a light net of Garstang's pattern are more theoretical than practical. Dr. Fowler has very kindly undertaken for me the superintendence of a heavy net of his pattern, which I propose to use in the Faröe Channel; and until I have compared the results of this net with those of the lighter net I defer any remarks as to the vertical distribution of the plankton of this area. An examination of his Copepods taken in his "Research" work (which he has very generously placed at my disposal) shows, however, how closely our results agree.

With the mass of material accumulated during three years' work it has been impossible for me to devote attention to more than two groups, viz. the Radiolaria and the Copepods. My attention was early attracted to the former group on account of the great number and considerable variety which occurred constantly round the Shetland coasts, and because there appears to have been but little work done with respect to this group in British waters. The few notes which Mr. Allen has kindly given me the opportunity of publishing in the Journal of the Marine Biological Association will, I hope, be amplified in a separate publication. The Copepods, the study of which has revealed several new forms, and extension to northern waters of many interesting forms of more or less constant occurrence round the Shetland coasts, will also be more fully dealt with later in a special monograph.

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* Mr. H. N. Dickson, of Oxford, has been kind enough to undertake the analysis of my water samples.

I am greatly indebted to Miss Marion Lees for the beautiful drawings which she has executed, and is still engaged upon, in illustration of my plankton preparations.

I. RADIOLARIA.

THE COLONY-BUILDING RADIOLARIA are well represented round the Shetland coasts and in the Faröe Channel. Haeckel, in the *Challenger Report,* described and figured (Plate III.) a Collozoum, to which he gave the name "*C. ellipsoides, n. sp.*" Fowler (*Proc. Zool. Soc.*, December 13th, 1898, p. 1024) speaks of a Collozoum, which he captured in 30 per cent. of epiplankton hauls in the Faröe Channel, of apparently two species, neither of which could be attributed to *Collozoum inerme* or to Haeckel's *Collozoum ellipsoides.*

COLLOZOUM.

A Collozoum which I have captured in several tow-nettings, and on many occasions round the coasts of Shetland, agreed in all particulars with the same organism which I also obtained in considerable quantity in surface tow-nettings in the Faröe Channel. It bears considerable resemblance to *Collozoum pelagicum* (Brandt), but does not fully agree in important particulars with any of the Collozoums described by Brandt or Haeckel.

The colonies are yellowish in colour, and sufficiently so when in quantity to colour the whole capture a yellowish green. The jelly is often delicate and easily torn. The colonies are for the most part elongated, rarely spherical. Except in what are probably very young colonies, the jelly is of moderately firm consistence. The individuals are at once distinguished by the presence of one or more bright yellow oil drops in the centre of the central capsule. The nests are not closely packed, and the spaces between them are fairly regular.

The zooids are for the most part spherical, and only in cases where division is in progress or about to take place is this form departed from. Then they are lengthened out in the axis, and are frequently "fiddle-shaped." Division appears to be in progress in most of the colonies captured by me in the autumn of 1900.

The central capsules have a diameter, in the spherical condition, of ·09–·10 mm., and are packed with small round cells. In many colonies the individuals contain only one oil drop, but most have two, and some even three or four, occupying the exact centre of the capsule, and in all cases of a deep yellow colour. Where zooids are undergoing division these oil drops are often small and numerous. A fine membrane appears to surround the central capsule, and round most nests there is a thick layer of granular protoplasm, from which arise numerous pseudopodia which ramify through the calymma, and are connected with the extracapsular bodies and spaces. The yellow cells (xanthellae) are numerous —12 to 20 or 30 in an individual—and where the central capsule is dividing many of these appear to be undergoing the same process. They have an average size of ·02 mm. Extracapsular bodies are numerous, and contain granular protoplasm, and often what look like small fat drops, but osmic acid fails to stain them.

The description of this Collozoum may be briefly put as follows:— Colonies, long and thin, more or less elongated, not segmented. Individuals, ·09–·10 mm. in diameter, round, with thick pseudopodia, central capsule very fine, "assimilation plasma" (Brandt) absent (?); two to four oil drops of bright yellow colour occupying the centre or major portion of the capsule; yellow cells (xanthellae) numerous, 12–30, situated in the "pseudopodia mother-bed" round the capsule.

Distribution: In surface waters round the whole coast of Shetland, and in the Faröe Channel.

The species under discussion—a more detailed description of which is reserved for a future occasion—while possessing some of the characters of *C. fulvum*, much resembles *C. pelagicum* in the possession of yellow oil drops, but differs from the latter in the great number of xanthellae, which in *C. pelagicum* are only 2–6 per individual. The size of the individual agrees more with *C. fulvum*. We must bear in mind the caution given by Brandt in his painstaking monograph on the colony-building Radiolaria, that it is very difficult to recognise the various Collozoums in their young stages. Besides *C. inerme, pelagicum, fulvum, hertwigii*, Brandt describes eight examples of skeletonless sphærozoida which do not conform with any of the above, some resembling *pelagicum*, others *inerme*, others having apparently distinct peculiarities. It may be remarked that Haeckel's description of *Coll. pelagicum* differs remarkably from that of Brandt,* and the latter, whose careful and minute descriptions, as I have found from experience, appear to be extremely accurate, remarks that under *Coll. inerme* both Haeckel and Hertwig have confused many different kinds. This northern species of Collozoum, which is certainly not *C. inerme*, appears to more nearly resemble *C. pelagicum* than any other kind.

Quite recently (September, 1901) I have found in Scapa Flow, in Orkney, day after day for a fortnight, quantities of a Collozoum which differs greatly from the organism just described. A detailed study

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* Haeckel (*Challenger Report*) describes *C. pelagicum* as having small, irregularly shaped central capsules, transparent and without oil globules, often many extracapsular vesicles in the jelly body. Membrane very thin and delicate. Diameter of central capsules, ·02–·08 mm.

upon living specimens has been possible, since I have captured it in the several stages of development, including the spore-formation stage. The colonies are for the most part globular, never segmented like *Coll. inerme*, the calymma is delicate and packed with zooids of ·12–·15 mm. diameter (smallest) to ·24 mm. (the largest), many in the same colony being quite round, others ovoid or elliptical, but varying as much in shape as size, long, fiddle-shaped (dividing) zooids measuring as much as ·34 mm. in length.

Similar variation existed in the number and size of the oil drops, the occurrence of one oil globule being quite exceptional, most colonies, except those in the spore stage, containing zooids with a central rosette of eight or nine colourless oil drops, while in long, fiddle-shaped zooids they were more numerous still. The xanthellae were very numerous—in many of the young reproductive colonies from 20–30, in individuals of other colonies, which are apparently the same species, being as many as 80-100 per individual. Staining with osmic acid failed to reveal any "assimilation plasma" (Brandt), and the pseudopodia were very fine and the pseudopodium bed surrounding the capsules of moderate thickness. While a detailed description is reserved for a further occasion, it is evident that the organism is not *Coll. inerme* or *Coll. pelagicum*, and I have little doubt that it is a new species. What is a further peculiarity is that the calymma is filled with diatoms exactly similar to those described by Brandt (and figured in Plate 2, Fig. 9, of his monograph),* † long bodies (·085 mm.) tapering to a fine point at each extremity, thicker in the middle, containing yellow pigment granules and four or five lightly refracting dots which stain darkly with osmic acid. They possess a certain degree of movement in a longitudinal direction, and I have watched them making to-and-fro movements of considerable length through the jelly. Some colonies have a yellowish appearance, to the naked eye, and this appears to depend mostly, if not entirely, upon the number of diatoms present, for the number of green cells does not appear to make any difference, and the oil drops are in all cases quite colourless.

Brandt has already described the occurrence of these diatoms in four colonies of a young kind of Collozoum, which he found in the Mediterranean and which did "not appear to be identical with any known species." The zooids in his Collozoum had a diameter of only ·07–·09 mm. and contained one colourless oil drop of ·023–·03 mm. diameter with a small pseudopodia layer and no assimilation plasma. This is practically all the description which he was enabled to give of this Collozoum, for which he was unable to assign a specific place.

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* Die Koloniebildenden Radiolarien.

† This does not appear to be an accidental occurrence, but a constant association.

I think it is possible that the *Collozoum ellipsoides* (*n. sp.*) described briefly by Haeckel.* ("central capsules regularly ellipsoidal, very large; length 0·3–0·4, breadth 0·2; in every capsule 50–80 oil globules") may be a stage of the same organism. This Collozoum has been watched by me in the spore-forming stages, and I have studied both the anisospore and isospore conditions. A study of these Collozoums has convinced me how little reliable can be a differential classification of these organisms based on the shape of the zooids, as indicated by Haeckel (p. 24 of the same monograph).

These swarms of Collozoum were observed in Scapa Flow to come to the surface on an exceedingly hot day with a burning sun and quite calm sea. As soon as any ripple of the surface occurred, with a breeze of wind, they disappeared below the surface, and were found 10–12 fathoms deep. It is probable that temperature affects them but little, as I experimentally submitted the living colonies to a temperature of 33° F. and found that after two hours' treatment they still floated at the surface, and at the other extreme a temperature of 80°F. did not affect their vitality. *Chœnicosphæra murrayana* has been captured by me, living, in the sea at a temperature of 29° F. Wind, tidal and other currents have probably more to do with distribution in these cases than temperature.

In assigning any Collozoum to its specific place, no system can be reliable which does not take into full account the various stages in the life-history of the organism. I therefore quote from Brandt's monograph the following data arranged in tabular form and with which I have incorporated the new species (to which I have given the name *C. brandtii*). These serve for the discrimination of the known European species, or as type forms round which others may be grouped.

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* *Challenger Report*, "Radiolaria," p. 26.

	Colony.	Zooids.	Central Capsule Membrane.	Assimilation Plasma.	Nuclei.	Xanthellae.	Behaviour under chromic acid.
1. Coll. inerme .	Sausage-shaped, with large vacuoles	0·1–0·13 mm. ; often irregular	Absent	Occurs	2 layers	Numerous ; nearly all round central capsule	Jelly dissolved ; zooids fall out
2. Coll. fulvum .	Round ; one large central vacuole	0·09–0·14 mm. ; generally round	Fine	Occurs	2 layers	Very numerous	Colony loses its form
3. Coll. pelagicum .	Thin, sausage-shaped ; often exceedingly long ; never segmented	0·8 mm. ; mostly round ; oil drops brown - yellow ; thick pseudopodia	Fine	Absent	1 layer	Few ; 2–6 pro individual ; all round the central capsule	Jelly dissolved ; individuals fall out
4. Coll. hertwigii .	Round	0·12–0·22 mm. ; mostly round ; often ellipsoid or kidney-shaped	Thick	Absent	?	Numerous ; all round the central capsule	Colony retains its form
5. Coll. brandtii (nov. sp.) .	Round or slightly elongated ; never segmented ; numerous vacuoles.	·13–·24 mm. ; ovoid, ellipsoid, or round ; oil drops 5–10, colourless	Absent in young condition ; extremely fine in isospore stage	Absent	1 layer	Very numerous ; usually 30, often over 100 ; round the zooid	Jelly partially dissolved ; zooids held more or less together by slimy threads of plasma

	Young Reproductive Stage, with Intracapsular Bodies.		Old Reproductive Stage.	
			Isospore Stage.	Anisospore Stage.
1. Coll. inerme. .	Fat colourless, in large drops	Yellow cells fall out in swarm stage	Crystals ·008–·01 mm. long inside nucleus ; isospores 0·012 mm.	Small crystals ; fat not distorted
2. Coll. fulvum .	Fat colourless, very small quantity		Crystals form outside, small ; isospores ·009–·010 mm.	Small crystals ; fat distorted
3. Coll. pelagicum .	Fat yellow, in large drops	Yellow cells remain in swarm stage	Crystals outside, small	?
4. Coll. hertwigii .	?			Fat distorted ; lumps smaller than in Coll. fulvum
5. Coll. brandtii (nov. sp.) .	Fat colourless, in small drops	Yellow cells retained	Crystals small and on outer side of nucleus	Fat breaks up into small drops ; very small crystals.

Note.—It is necessary to comprehend the term "Assimilation Plasma" as used by Brandt. By this is meant a peculiar form of plasma which is in some species contained in the pseudopodia bed round the zooids, and occasionally in the pseudopodia, and which by its behaviour to reagents appears to be chemically different from ordinary plasma. It is chiefly distinguished by its reaction to osmic acid, with which it stains brown or black, while the remaining plasma remains unaffected. It probably has some metabolic function, and appears to be entirely absent in some species.

SPHÆROZOUM (OVODIMARE (?) *Haeckel*). Plate I., Fig. 5.

On one occasion only during two years' work have I captured in the tow-net a Sphærozoum. This was at a position almost due west of Papa Stour, in Shetland, and first on the 100-fathom line.

The colony possessed a clear white and firm calymma, with thin strands of finely granular protoplasm. Individuals were of comparatively large size, the largest averaging ·12 mm. diameter, circular, greenish yellow in colour, containing numerous small cells, and in the centre one large oil drop. The individuals were surrounded by a fine membrane, and there were numerous xanthellæ from 12–20 round each individual. It bore a striking resemblance to Collozoum except for the presence in the calymma of numerous needles lying between, but not upon, the individuals. They consisted invariably of a straight central rod, and generally of three processes or shanks, arising at an oblique angle from each end of the rod. Some rods possessed four shanks at one end, but the general rule was three. They varied much in size, the largest needles being: rods, ·002 mm. long; shanks, ·003 mm. long. The latter were invariably longer than the rods. Many were quite plain, but others had short, minute processes or thorns on their edges, never, however, so marked as those figured in Haeckel's monograph as characteristic of *Sph. punctatum*. In this species also, according to Haeckel, the rod is longer than the shanks.

The presence of scattered needles in the calymma suffices to diagnose this Radiolarian as a Sphærozoum. Four species are described by Haeckel as Atlantic or common forms: (1) *Sp. hexactinium* (captured in the Faröe Channel), having six or seven curved shanks; (2) *Sp. ovodimare* (Mediterranean and Atlantic); (3) *Sp. punctatum* (cosmopolitan in warmer seas); (4) *Sp. quadrigeminum* (North Atlantic), four shanks at each end of the rod.

All colonies with tangential "punctatum" needles are placed by Brandt under the designation of *Sp. punctatum*, but he remarks that there may be many kinds. While this particular Sphærozoum is obviously not the one described as *Sp. hexactinium* from the Faröe Channel by Haeckel, it agrees in the fact that the shanks are longer than the needles, and more or less in the size of the central capsule with his *Sp. ovodimare*, and may be provisionally placed with that.

COLLOSPHÆRIDA.

CHŒNICOSPHÆRA MURRAYANA.

This is the commonest form of colony-building Radiolarian occurring on the coasts of Shetland, and I have found it in most tow-net captures from September to March. It was originally briefly described by

Haeckel as found in the Faröe Channel and named by him after Sir John Murray.

The colony is a hollow sphere of rather tough jelly of from 3·6 to 4 mm. diameter, and the zooids are dotted over it in little white spots, making it quite easy to identify with the naked eye. The cell nests average ·18 mm. diameter. The central capsule, of pale yellow-green colour, occupies the greater part of every shell, and averages ·11 mm. diameter. In the centre is one oil globule of ·05 mm. diameter. Between the central capsule and shell is a thick layer of granulated protoplasm, and outside the shell is another similar layer, from which issue pseudopodia in all directions. Each shell individual appears to lie often in an alveole with a distinct finely granulated boundary. The shells have an average diameter of ·18 mm.

In the thick "pseudopodia mother-bed" lie the xanthellae, which also occupy the pores of the shells. They are very numerous. Strands of granular protoplasm radiate from the circumferential layer, throughout the jelly mass. For the most part they are not thick, and extra-capsular bodies are few and small.

The shells have a general resemblance to the figure in Haeckel's *Challenger Report*, and many of them answer to his description:—

"*Chœnicosphæra n. gen.*—Collosphærida with simple shells, armed on the outside with radial spines, forming elegant coronals around the larger pores.

"Sub-genus 1. *Chœnicosphærula.*—A coronal of spines around every pore of the shell" (*Challenger Report*, vol. xviii. p. 102).

The examination of a large number of specimens shows that the number of spines forming the corona is very variable, frequently six or seven, but often less. In the same shell in which some of the pores may have the typical corona others are found with few spines or none at all.

The pores are of unequal size, some large, others small, distributed irregularly, but ten to twelve in the half-meridian.

The coronal spines are very short and there are no spines between the pores.

It is probable that there is more than one variety of *Ch. murrayana.* All the kinds captured by me in the Faröe Channel and Shetland waters can only be referred to the sub-genus "Chœnicosphærula" (Haeckel), though it may be remarked that the classification founded on the character of the shell only and the coronals of the pores is necessarily a very artificial one.

The form and disposition of the zooids in the calymma appear to vary with the age of the colony. In some instances individuals are met with having an oval shape side by side with spherical individuals.

On other occasions what are probably very young individuals appear to be without shell, and bear much resemblance to a Collozoum. The number of the coronal spines round the pores of the shell varies considerably, and it is probable that the *Trypanosphæra brachysiphon n sp.* briefly described by Cleve is really a Chœnicosphæra.

Of the other Collosphærida I have found only shells of *Acrosphæra spinosa,* never a colony. These have been brought up in the tow net vertical hauls, on the west coast of Shetland, on three occasions. Its appearance in this locality can be little more than accidental. The shell is a perfect sphere with many short conical spines, rather broad at the base, and tapering to a point and slightly curved. All the spines are similar. They arise at the base from an upward process of shell at the side of the pore, causing the base to appear as if perforated. The pores are irregular in size, large and small being irregularly distributed. The bars between the pores are three or four times the diameter of the smaller of the latter.

Diameter of the sphere, ·21; length of spines, ·002 mm.; width of largest pore, about ·0012; widest bars, ·001 mm.

The shell has much resemblance to *Ac. echinoides* (Haeckel), but does not fully resemble either that or *Ac. spinosa.*

THALASSICOLLIDA.

1. Thalassicolla nucleata.

This is taken with great frequency in the surface tow net in the coastal waters of Shetland and in the Faröe Channel, and I have found it in quantities in the mid-water net at a depth of 40 to 50 fathoms.

The organisms are, to the naked eye, little spherical balls of clear jelly with a darkly pigmented centre, often densely black, less often cinnamon-brown or yellow. The colour of the pigment is variable.

The thick jelly calymma is characterised, as Hertwig remarked, by (1) the richness in black pigment, (2) the numerous vacuoles. The latter are small near the central capsule, larger towards the periphery. The pigment is contained in a thick layer of the extracapsular sarcode surrounding the central capsule, and is a dense layer of very small round, black, or brown cells. From this layer it radiates in small quantity through the protoplasmic strands which pass in all directions between the vacuoles. Slight pressure of the cover glass is sufficient to shell out the central capsule from the surrounding pigment layer. It is surrounded by a firm membrane,* which on its inner side is lined with a continuous layer of polygonal areas, and perforated by numerous pores. In the centre of the capsule is a rounded nucleus, which, as Hertwig remarks, is easily shelled out of the capsule by pressure, owing to its thick wall.

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* The dissection of this membrane from the central capsule is very easily accomplished without previous treatment of the specimen.

The contents of the central capsule are rounded bodies of various constitution, some containing oil drops, some granular protoplasm, others pale and clear, and oil drops of varying size, some few of which are large and of cinnamon colour. Numerous vacuoles occur, large and small.

The nucleus has an investing membrane sufficiently dense to allow of its being readily shelled out of the central capsule on pressure. It is closely packed with small round cell-like bodies, amongst which are some large oval, or ellipsoidal, nucleated bodies. The colour of the nucleus is yellow. Diameter of the calymma, 3–4 mm.; of the central capsule, 1·1 mm.; of the nucleus, ·05 mm.

2. THALASSICOLLA PELAGICA (Haeckel, *Die Radiolarien*, 1862).

This species is distinguished by the small size of the central capsule in comparison with the calymma, the pellucid appearance of the latter, the small amount of pigment, and pale white or yellowish white colour of the central capsule. The jelly of the calymma is much less firm and consistent than that of *Th. nucleata*, and the pigment is much less distributed in strands through the calymma than in the latter, and is nearly entirely grouped round the central capsule. The membrane surrounding the central capsule is thin, and though marked with very close dots (pores), does not possess the polygonal cell area markings of *Th. nucleata.*

The contents of the central capsule are small, round bodies, packed densely between which are many small oil globules, but the latter are grouped into larger drops chiefly round the outer rim of the central capsule and within the central capsular membrane. Between the intracapsular bodies are many small vacuoles, often containing small oil drops.

The nucleus has a fine and porous investing membrane, and is papillated with irregular-shaped protuberances about as long as the radius, and there are a few long, tube-like or vermiform bodies. The rest of the contents of the nucleus appears to be made up of small rounded bodies, between which are spaces resembling vacuoles. Diameter of the calymma, about 3–4 mm.; of the central capsule, 0·4–0·6 mm.; of the nucleus, ·02 mm.

The third kind of Thalassicolla possesses a remarkable central capsule, and it has been suggested to me that it should be referred to a new genus, for which the term Thalassiosolen is proposed.

3. THALASSIOSOLEN ATLANTICUS (*nov. genus et nov. sp.*).

In general appearance the animal resembles *Th. nucleata,* in the possession of a vacuolated calymma and a central capsule surrounded by black or dark brown pigment. This latter is very thick, and extends between the extracapsular vacuoles in thick strands. The calymma and vacuoles are otherwise like *Th. nucleata.* The central capsule shells out quite easily, and its investing membrane (which is readily dissected off with needles) is much thinner than that of *Th. nucleata,* but, like the latter, is perforated by multitudinous fine pores, apparently more numerous than in *Th. nucleata,* but showing on its inner surface the same polygonal area markings as *Th. nucleata.*

A narrow space is observed all round the capsular contents and just within the capsular membrane, in which I have been unable to trace anything but oil globules. The whole of the centre of the capsule is occupied by layers of radially disposed, rounded tubes, closely packed in two (or three ?) layers converging towards the centre, where their ends lie over and around the nucleus, without, however, any intimate connection with the latter, and towards the periphery branching into two, or sometimes three, club-shaped, closed ends. Throughout the rest of their course they are usually quite straight, and are rarely branched at their proximal ends. These tubes are yellowish in colour, and appear to contain granules and irregularly shaped bodies, which stain deeply with osmic acid. As they dissolve completely in mineral acids they are not of siliceous nature. They leave behind nothing but oil drops. With prolonged treatment by caustic potash the contour of the tubes is not altered. Stained with picrocarmine, the tubes are seen to be filled with granules deeply stained and with clear spaces between them. Treated with ether, and subsequently stained with picrocarmine, the tube contents are unaltered, except that the granules stain deeper than the rest. Osmic acid stains them dark brown or black. They are not fat, and bear a remarkable resemblance to the "assimilation plasma" of the Collozoums. It is difficult to rupture the tubes, and they always break transversely. The granules are arranged down the sides of the tubes, apparently firmly adherent to the walls, and the lumen of the tubes contains a clear space (? filled with fluid *intra vitam*).

There do not appear to be any vacuoles in the central capsule, as in other Thalassicollidæ, but oil drops of irregular though often considerable size occur between the tubes.

The nucleus is round, and the investing membrane rather dense, and it does not rupture easily. It is packed with small round bodies, with a few of larger size, but contains no vacuoles. A few large cinnamon-coloured oil drops are irregularly distributed in its contents.

Diameter of calymma, 2·6 mm.; of central capsule, 1·4 mm.; of the nucleus, ·18 mm.

CŒLODENDRIDA.

Cœlodendrum ramosissimum is not unfrequently found in Shetland waters, and I have captured it on the east as well as on the north and west sides.

The skeletal tubes branch dichotomously, each sub-branch doing the same, and becoming progressively smaller and thinner towards the periphery. These tubes are hollow, and the branches are given off nearly at right angles. The smallest and terminal twigs are each surmounted by eight small recurved teeth and end in a knob. The main branches arising from the galea are closed. At each pole three branches arise from the galea, two being together and one a single one. The central capsule is enclosed in a two-valved shell, with numerous large pores of irregular size, a peculiar hard ridge on the surface, and a curved process at the side. The shell is perforated at the base and sides by small, round, irregular pores.

The phæodium is large. Diameter of the entire animal, ·8 mm.; length of principal branches, ·07 mm.; diameter of shell valves, ·06 mm.

AULOCANTHIDA.

Aulacantha scolymantha (*Haeckel*). Plate I., Fig. 3.

This is a common Radiolarian round all the coasts of Shetland, where I have taken it in greater abundance than in the open waters of the Faröe Channel. As the spines are almost invariably toothed, whereas in Haeckel's *A. lævissima* (the only known habitat of which is the Faröe Channel) the spines are smooth, my species cannot be referred to the latter. At the same time it must be remarked that they do not quite agree with *A. scolymantha* as received (in the preserved condition *) from Naples, nor quite with Haeckel's pictures (Monograph, 1862), the differences being in the almost invariably excentric position of the central capsule, the smaller quantity of phæodium, and the character of the radial tubes. These taper at each end, and are thickest in the middle. The proxinal end tapers to a rounded extremity, and the distal to a blunt point. Many tubes are slightly curved distally. They bear from 5–15 minute teeth subalternately placed along the edges of the spines, but only in their distal fifth.

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* In my experience no method of preservation retains the form of the animal in such a normal condition as the well-known 5 per cent. formalin. Specimens may be observed in detail on shore when opportunities fail—as they usually do—at sea, within a few weeks with practical certainty that the organisms have retained their normal condition. Spirit or other preservative certainly distorts to a considerable extent.

The measurements (from average-sized specimens) are: Diameter of the calymma, ·73 mm.; of the central capsule, ·16 mm.; length of the radial tubes, ·75 mm.; greatest thickness, ·01 mm. The radial tubes number from 28–30, never more; the tangential network which surrounds the jelly consists of fine needles, which form a mesh without branching. Like the radial tubes, they are not dissolved by mineral acids. The central capsule is covered with a tough investing membrane, has an operculum (striated), and a nucleus occupying its centre and about half its size. The phæodium is copious.

AULOGRAPHIS FURCELLATA, *n. sp.* Plate I., Fig. 1.

This species was captured at 250 fathoms. The animal, in shape more or less spherical, had a diameter of 1·5 mm. The calymma contains a tangential needle system, the needles being thicker than those of Aulacantha, but while crossing and recrossing one another, nowhere branched or anastomosing. The central capsule lies in an extensive phæodella, of which many of the green cells are of very large size. Radiating through the calymma are about 40 tubes, many of which are slightly curved distally. They are broad towards the proximal end, and taper as a rule but slightly towards the distal end; all appear as if grooved in the outer portion, and while some are very broad, others are of much slighter build. At the extremity of each radial tube are two very short simple branches, bearing neither teeth nor spathillæ. Each is curved and more or less crescent-shaped.

Length of tubes, ·3 mm.; breadth, ·09 mm. (in middle).

I am unable to refer this to any of Haeckel's Aulographantha, though it bears all the characters of the genus Aulographis. It certainly does not correspond to either of the three forms, *A. pistillum, penicillata, pandora*, the habitat of which is the North Atlantic.

AULOGRAPHIS TETRANCISTA (*Haeckel*), *variety.*
Plate I., Figs. 2 and 2a.

In this animal there is a tangential needle system in the calymma of rather thick single rods, resembling the last-mentioned species. The diameter of the whole animal is about 2·3 mm., and there is an extensive phæodella. The tubes are frequently slightly curved, a few considerably bent at the distal end. Thick and broad in the middle, they taper towards each end, but more at the proximal extremity, where they terminate in a rounded end. Towards the distal extremity they appear grooved. Each radial tube carries a verticil of four (rarely five) thin and rather long divergent branches, slightly curved. Each terminal branch ends in a cushion carrying four or sometimes five very small teeth.

Length of the tubes, ·88 mm.; breadth in the middle, ·08 mm. The length of the terminal branches varies; some are thick and stout, others longer and thinner, five to ten times as long as broad.

This Radiolarian bears considerable resemblance to Haeckel's *Aul. tetrancista* and *hexancista*, both of which are Pacific deep-water forms.

My specimen was taken at 400 fathoms in the Faröe Channel, and is probably to be regarded as a North Atlantic variety of *Aulographis tetrancista*, from which it differs slightly.

AULODENDRON BOREALE, *n. sp.* Plate I., Figs. 4, 4a, 4b.

A Phæodarian was captured at 400 fathoms, which, though very much broken and injured, showed some characters distinct enough to enable it to be placed in Haeckel's genus Aulodendron ("Aulocanthida with a veil of tangential needles, and inter-radial tubes which bear numerous irregularly scattered lateral and terminal branches."—*Chall. Rep.*, p. 1588).

The calymma measured 2·5 mm. across; was covered with a veil of stiff, straight, tangential needles unbranched and not anastomosing, but of considerable thickness, the needles measuring in width ·01 mm.

The radial tubes, which were irregularly scattered, were very numerous, straight, of fairly equal thickness throughout their length, tapering only slightly or not at all at the proximal end (Fig. 4a), but at the distal end having a constriction below the verticil, which formed a rounded knob bearing in some four, in a few others six slightly curved branches, widely divergent, about ·055–·060 mm. long, and thin (Fig. 4).

In the outer half of the radial tubes branches were given off at irregular intervals, generally alternate, but often two on one side close together. These branches are short and carry a forked or slightly denticulate knob at the extremity (Fig. 4b), and of about the same length as the branches of the verticil. Generally there were twelve lateral branches, all of about the same length. Often they are again branched, the terminal twigs being very small. The length of the radial tubes was very variable, averaging about ·12 mm., and the width was similarly variable, some not being more than half the width of others, but averaging ·02 mm. The proximal ends of the tubes lie centrally over the phæodella, which is very copious.

The animal, while being undoubtedly an Aulodendron, is difficult to place specifically owing to its mutilated condition, but it does not appear to agree with any of the five species described by Haeckel (p. 1589, *Chall. Rep.*), none of which are North Atlantic forms. It is therefore interesting to note the occurrence of the species in the North Atlantic. The characteristics of the radial tubes are quite peculiar.

CHALLENGERIDA (*J. Murray*, 1876).

These singular organisms are not uncommon* round the Shetland waters and in the cold area of the Faröe Channel, and I have taken them both in surface and deep tow-nettings. One species, captured by me off the north coast of Shetland in a surface tow-netting, appears to be new.

CHALLENGERON WALWINI, *n. sp.* Plate II., Figs. 1, 1a.

The shell, which is longer than broad, presents the usual "diatomaceous" structure. Its margin has twenty-five spines, of which that at the aboral pole is the largest; on each side of this spine is a very short spine. The other spines round the lower edge are long, though not so long as the apical spine, and progressively and regularly diminish in size towards the peristome. The latter presents two lateral slightly curved and divergent teeth and a dorsal bifid tooth. All are beset with short and sharp spines. There is no pharynx.

Dimensions.—Length of the shell, ·18 mm.; of the body, ·11 mm.; of the peristome, ·07 mm.; of the lateral teeth of the peristome, ·03 mm.; of the principal aboral spine, ·03 mm.; breadth of the shell, ·09 mm.

This animal would appear to belong to Haeckel's subgenus "Challengerosium" ("margin of the shell dentated or serrated with a continuous series of numerous short radial spines"), all of which, with the exception of one (as to which the depth is not stated), *C. johannis* (taken in the Faröe Channel, Gulf Stream), are deep-water species, and tropical or Pacific.

It was captured at Station V., February 9th, 1900, at the surface.

It is closely related to *C. willemœsii* (Haeckel), but differs in having a smaller number of marginal spines (in *C. willemœsii* these are fifty to sixty), and the spinulation of the peristome also differentiates it from this.

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* In some hauls, *e.g.* Station A1, in August, 1900, they were captured in great quantity in the Mesoplankton, chiefly at 350 fathoms.

CHALLENGERON BALFOURI (? *var.*), *J. Murray.*
Plate II., Figs. 2 and 2a.

Shell rather broader than long towards the base, compressed laterally, of the usual diatomaceous structure. At the aboral margin are two short conical teeth—one on the ventral, the other on the dorsal aspect. The peristome is deeply cleft ventrally, and strongly keel-shaped dorsally. It is bifid at the apex, with one tooth rather shorter than the other. The peristome is marked with transverse ridges (not the diatomaceous shell structure), especially in the cleft of the ventral side and along the external surface of the peristome and edge of the teeth. The mouth is wide, and has no pharynx.

Length of the shell, ·2 mm.; breadth, ·212 mm.; length of the peristome, ·093 mm.; length of the aboral spines, ·03 mm.; width of the mouth, ·05 mm.

CHALLENGERON BALFOURI, *variety*. Plate II., Figs. 3 and 3a.

This species resembles the preceding, except in the characters of the peristome, which is stouter and posteriorly produced into a rather prominent elbow, above which the peristome ends in two pointed divergent teeth. The peristome is strongly marked with ridge markings, but not on the elbow, and on the ventral aspect in the groove. It is essentially the same, except in the characters of the peristome, as the last species. It was taken at 350 fathoms along with the last species.

Neither of these two species exactly corresponds with Haeckel's description of *C. balfouri* (*Challenger Report*, "Radiolaria," p. 1655), which was a surface species. Both the examples described are probably deep-water varieties of *C. balfouri.*

CHALLENGERIA TRITONIS (*Haeckel*). Plate II., Fig. 4.

The shell is longer than broad, ovate seen from the dorso-ventral aspect, marked apparently diatomaceously; but this is not of the usual aspect, but consists of simple rounded pits, many of large size, and the usual hexagonal framework between the pits is absent in this case.

The mouth is comparatively small, and forms a rounded opening, situated rather on the ventral aspect of the shell. There is a long peristome tapering to a blunt point, directed vertically, and having fine markings on the dorsal and ventral sides, unbranched and possessing no teeth.

Length of the body of the shell, ·2 mm.; of the peristome, ·1 mm.; width of the body of the shell, ·17 mm.; width of the mouth, ·04 mm.

CHALLENGERIA ZETLANDICA (*n. sp.*), Plate II., Fig. 5.

Shell subspherical and strongly compressed (oval seen sideways) with the usual diatomaceous markings. The peristome is long, and at the base nearly as long as the shell, and ovate, and terminates in one bifid tooth. The whole peristome is strongly directed towards the ventral side. The shell is much longer than Haeckel's *Ch. sloggettii*, and the aboral line is rounded, not straight, as in *Ch. sloggettii*. It differs from both *Ch. sloggettii* and *harstoni* in the possession of a single bifid tooth, instead of two parallel teeth.

The shell is also much smaller than any of the Challengerida with which I am acquainted, being only ·053 mm. long and the peristome ·03 mm. long. The width of the shell (dorsally) is ·03 mm.

II. COPEPODA.*

The Copepoda of the Faröe Channel have been briefly reported on by I. C. Thompson for Fowler (Research Expn. P.Z.S., 1897). In the same paper a list is given of these, with the areas of their vertical distribution. For the present I withhold any comment on these results, my own work in the Faröe Channel not yet being completed, and will only remark that my own captures with Garstang's closing net in the deeper waters of the Faröe Channel have produced results agreeing in the main with those of Fowler. With work which has accumulated during three years it will be readily understood that it must take a considerable time before a complete survey can be given. I append a first list of Copepoda taken during these expeditions:—

IN THE SHETLAND WATERS.	IN THE FARÖE CHANNEL.
Calanus finmarchicus.	*Calanus finmarchicus.*
Calanus parvus.	*Calanus parvus.*
Calanus hyperboreus.	*Calanus hyperboreus.*
Pseudocalanus elongatus.	*Pseudocalanus elongatus.*
Rhincalanus nasutus.	*Rhincalanus nasutus.*
	,, *cornutus.*
Eucalanus elongatus.	*Eucalanus elongatus.*
	E. attenuatus.
	E. crassus.
Euchæta norvegica.	*Euchæta norvegica.*
	E. barbata.
	E. marina.
	Euchirella carinata (*nov. sp.*).
	E. rostrata (?).

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* The Copepoda of the Faröe Channel will form the subject of a subsequent monograph.

IN THE SHETLAND WATERS.	IN THE FARÖE CHANNEL.
Oithona spinifrons.	*Oithona spinifrons.*
Acartia clausii.	*Acartia clausii.*
,, *discaudata.*	
Oncæa mediterranea.	*Oncæa mediterranea.*
,, *subtilis.*	,, *subtilis.*
Metridia lucens.	*Metridia lucens.*
,, *longa.*	,, *longa.*
Temora longicornis.	*Temora longicornis.*
Anomalocera pattersoni.	*Anomalocera pattersoni.*
Centropages typicus.	*Centropages typicus.*
Candace pectinata.	*Candace pectinata.*
Pleuromma abdominale.	*Pleuromma abdominale.*
	,, *robustum.*
	,, *abyssale.*
	Heterochæta clausii.
	,, *spinifrons.* [*longicornis*)
	,, *zetesios* (*nov. sp.*), (*non-*
	Tetragoniceps —— (*nov. sp.*).
	Scolecithrix —— (*nov. sp.*).
	Ægisthus atlanticus (*nov. sp.*).
	Leuckartia flavicornis.
	Augaptilus zetesios (*nov. sp.*).
Ætidius armatus.	*Ætidius armatus.*
Ectinosoma atlanticum.	*Ectinosoma atlanticum.*
Thaumaleus longispinosus.	*Gaidius boreale* (*nov. sp.*).
Pseudocyclopia giesbrechtii (*nov. sp.*).	
Cyclopina gracilis.	
Sapphirina (*nov. sp.*).	

I have intentionally not included in this list the Harpacticidæ. It will be noted that several of these Copepods are new species, and I may add that they will form the subject of description subsequently, when the drawings are completed.

There are several additions to the list given in Fowler's paper (*loc. cit.*), notably *Pleuromma robustum, Heterochæta clausii, H. zetesios, Augaptilus, Oncæa, Eucalanus elongatus* and *crassus, Tetragoniceps, Scolecithrix, Rhincalanus nasutus,* and *Ægisthus.*

The limits of distribution of the following "warm-water species" are extended by these observations:—

*Euchirella; Eucalanus attenuatus, E. crassus;** *Euchæta barbata; Heterochæta clausii, H. spinifrons; Leuckartia flavicornis; Scolecithrix; Oncæa mediterranea* and *subtilis; Pleuromma abdominale; Rhincalanus*

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* *Eucalanus crassus, Pleuromma robusta, Ægisthus, Augaptilus* I found in Fowler's collection, the two first also occurring in my own tow-nettings.

cornutus and *nasutus; Thaumaleus; Ætidius armatus; Augaptilus; Ægisthus; Gaidius.*

Perhaps the most remarkable in this list is *Ægisthus,* of which only four examples are recorded by Giesbrecht, the limits of the species being 3° S. and 3° N., 99° W.

The common *Eucalanus* of the Faröe Channel is *E. elongatus. E. attenuatus* is very uncommon. *Eucalanus elongatus* is frequently found round the Shetland coast, and on one occasion I took a quantity in Scalloway Deeps.

Rhincalanus nasutus, common in the Faröe Channel, is also often captured off the Shetland coasts. *Pleuromma abdominale* I have only once captured off the north coast of Shetland, and *Pleuromma robustum* is quite as common in the Faröe Channel as *P. abdominale.*

Oncæa is common in deep water and up to surface hauls in this region. *Euchæta norvegica* I have never taken at the surface, though not unfrequently at forty to fifty fathoms' depth, but this being in an open "mid-water net," it may very well have been caught on the way up.

Scolecithrix is not uncommon in the Faröe Channel, but I am unable to refer my specimens to any described species. Curiously I have never succeeded in finding (though I have sought diligently) the *Metridia normani* which Giesbrecht records from the Faröe Channel. In few tow-nettings is *M. lucens* (and in deep water *M. longa*) absent, and of very common occurrence is a ♂ *Metridia* with the clasping antenna on the left side, but this species is certainly not *M. normani.* It very greatly resembles *M. lucens,* except for the peculiar position of its clasping antenna (left side).

Leuckartia flavicornis and *Thaumaleus* have each been captured only once. The occurrence of such forms as *Ægisthus, Augaptilus,* and *Gaidius* in these northern waters is very singular. *Calanus hyperboreus,* which occurs occasionally around the Shetland coast and frequently in the Faröe Channel, is described by Giesbrecht as a distinct species. Thompson, in his report on Fowler's Copepods (*loc. cit.*), is inclined to regard it as merely a larger variety of *C. finmarch.;* but I see no reason to doubt the correctness of Giesbrecht's view, that it has specific differences from the latter.

Augaptilus, Euchirella, Gaidius, and *Heterochæta* appear to be deep-water Copepods, and not to approach the coasts. *Anomalocera* is apparently one of the very few Copepods (not Harpacticidæ) which never descend into deep water, probably never below fifty fathoms.

ÆGISTHUS ATLANTICUS, *nov. sp.* (One specimen only, which I found in Dr. Fowler's Research Collection.)

Size 1·45 mm. Tail setæ 5½ times the length of the whole body, and coalescent throughout their course until just at the end. One is a little shorter than the other, and each ends in a peculiar spine, which articulates with the seta, and probably serves to fix the animal in the mud. This animal, unlike any other Copepod, possesses a sixth pair of feet, each a simple process with two hairs. The fifth feet are characteristic, long, and consist of only one segment. The inner terminal fan differs from Giesbrecht's species *mucronatus* and *aculeatus*, arising more proximately than in either of these, and not reaching the end of the terminal fan. The other feet have three-jointed outer and inner branches, and the second basipodite is joined to the first in quite characteristic manner (see Giesbrecht's figures, Fauna und Flora Neapel, Pl. 49).

The anterior antennæ consist of six joints; on the upper margin of the second joint is a strong spine proximally bent, and a long peculiar process (sensory ?) on the third joint, and a similar one on the end joint. The maxilla and post. foot jaw agree closely with *Æg. mucronatus* (Giesbrecht). Of the mandibles only the biting end remains.

The body of the animal is more or less torpedo-shaped, and the head narrows in front, and is produced into a long stout spine, curved downwards and forwards. The animal bears some resemblance to *Æg. mucronatus,* but is little more than half the size, differs in the length and terminations of the tail setæ, the presence of a long sensory process on the last joint of the anterior antenna, the possession of a three-jointed internal and external branch of the second feet (two-jointed in *mucronatus*), the disposition of the fan bristles of the fifth feet, the length of the bristles on the sixth feet (longer than *mucronatus*), the absence of teeth on the posterior edges of Th. 2, 3, and 4.

ÆTIDIUS ARMATUS.

The examples captured by me in the Faröe Channel and round the Shetlands fall into two groups, and further study will probably warrant the differentiation of more than one species.

A large number of apparently adult specimens attain a size only of 1·65–1·7 mm., and in these the rostrum is large and strongly chitinised, the anterior antennæ reach quite to, or a little beyond, the end of the furca, and the tenth, eleventh, and twelfth segments are proportionately a little larger than in the second species, and more or less coalesced. The pointed angles of the last thoracic segment are also dorsally more prominent and the spurs are shorter than in the other group (in which they reach beyond the end of Ab. 2).

In the second group the animals are much larger, 2·0–2·3 mm. long, the rostrum is smaller, the angular point of the last thoracic segment longer, and the antennæ are shorter, reaching only to the end of the first abdominal segment, and the joints 10, 11, 12 are more clearly segmented.

The specimens examined agree more closely with Giesbrecht's description than Brady's (*Challenger Report*), whose drawings and descriptions contain many inaccuracies. Brady gives the size of *Ætidius armatus* at 2·1 mm., Giesbrecht 1·55–1·9 mm., and the latter speaks of the variability in length of the points of Th. 5. These differences may be accounted for by the occurrence of two closely allied species, further discussion of which I defer for another occasion.

GAIDIUS BOREALE, *nov. sp.*

Half a dozen specimens captured at 300 fathoms at station A2 exhibited the following characters as described by Giesbrecht (*Bull. Mus. Comp. Zool. Harvard*, 1895): Short, one-pointed rostrum; the last thoracic segment produced into a long and sharp point. The inner branch of the posterior antenna : outer half :: 5 : 8. The bristles of the inner branch are 8 + 6. The head rounded, and without crest. Abdomen of four segments, the genital segment strongly swollen, but quite symmetrical. Of the swimming feet, the first has a two-jointed exopodite and one-jointed endopodite; the second, third, and fourth have three-jointed exopodites, but while the third and fourth feet have three-jointed endopodites, the second foot has an endopodite with only one joint like the first foot. There is an indistinct trace of segmentation into two joints.

The maxilla and mandible resembles Gaetanus. In the posterior foot jaw the second basal, which is longer than the first, is about three times as long as the five-jointed endopodite. The fourth feet have the stiff, broad bristles on the inner margin of the second basal, which slightly resembles the lamellæ of the same foot of *Euchirella rostrata*, and of which Giesbrecht remarks, "Die Fiedern am proximalen Theile des Innenrandes des 1 Basalgliedes sind am 4 Fusse breiter, und, wie es scheint, steifer als an den vorhergehenden Füssen, worin man einen Uebergang zu den Lamellen und Stacheln finden wird, welche sich bei *Euchirella* an der gleichen Stelle finden" (*loc. cit.*).

The size of my animals is 3·55 mm. (♀), while that of Giesbrecht's is 3·2 mm. The limits of distribution of Giesbrecht's species were

35° N. to 125° W. My species differs a little from Giesbrecht's, and may be, from the locality of its occurrence, designated *boreale*. Only a brief description of *Gaidius pungens* is available (*loc. cit.*), the only described species.*

EUCHIRELLA CARINATA ♂ *nov. sp.*

A male taken at A2, 300 fathoms, measured 3·71 mm. long, the fore-body six times as long as the abdomen. The last thoracic segments are rounded. The head is produced into a curious rostrum rather like *E. galatea* ♀, and dorsally there is a strong crest. There is red pigment about the mouth organs and the mandible chewing end is strongly coloured deep orange-red, the foot jaws having their bristles similarly but slightly coloured. The anterior antennæ reach just to the hind end of the thorax and consist of twenty-three joints. The feet have three-jointed exopodites except the second, in which they consist of only two joints, the endopodites of the first feet have one, those of the second feet two, and of the third and fourth feet three segments. There is a pair of rudimentary fifth feet, consisting each of an exopodite and endopodite. The right foot is a little the largest, its external branch of only one segment, in which are indistinct traces of three joints; the terminal joint ending in a blunt rounded process. The internal branch is of one stumpy rounded segment only. The left foot has a one-segmented outer branch, with blunt rounded end, and a short (not half the size of the opposite foot) rounded segment, like a small stump. Neither foot has any trace of spines or hairs.

The anal segment is very short and tucked into the fourth abdominal segment as in other Euchirellas.

The external branch of the posterior antenna is over three times as long as the inner branch, which carries 6 + 5 bristles at the end.

There are no spines or bristles on the first basal of the fourth foot.

The twentieth and twenty-first joints of the anterior antennæ are not coalesced, but the antennæ strongly resemble those of Euchirella. 8 and 9 and 24 and 25 are joined.

This Copepod agrees with Euchirella in the possession of twenty-three jointed anterior antennæ, the shape and number of segments of the abdomen, the segments of the branches of the feet, and the posterior antennæ. The maxillæ and foot jaws are well developed, the former very similar to the maxilla of the ♀ *E. messinensis*, the second basal joint of the posterior foot jaw is not quite twice as long as the well-developed five-jointed endopodite; in the anterior foot jaw the lobes are large, compressed, and the endopodite articulates behind, as in Ætidius. The hooked bristle on the fourth lobe is very strong and longer than that in the fifth lobe. This organ greatly resembles *E. rostrata.* The animal resembles no known ♂ Euchirella (*E. amœna, E. messinensis, E. pulchra*), but though comparatively large, it may be an undeveloped ♂. It will be figured and described subsequently.

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* The nearest related genus is Gaetanus (Giesbrecht), but this Copepod is removed from it by the absence of any median spine on the head. The indistinct traces of segmentation of the first and second feet cause it to approach the genus Gaetanus, while the lamellæ of the fourth feet (basal joint) again differentiate it. On the whole, it approaches more nearly to Gaidius than Gaetanus.

EUCHIRELLA ? ROSTRATA *(? var.)* ♀.

Size 3·8 mm. There is no crest, but a one-pointed rostrum. The abdomen and genital segment are quite symmetrical. The anterior antennæ have twenty-three joints. The internal branch of the posterior antennæ is as 5 : 8, and the end of the endopodite carries 6 + 5 bristles. The fourth feet have peculiar spines on the inner margin of the first basal joint, four in number, one of which is large (the proximal), the others progressively smaller and further proximally from the stout inner hair than in *E. rostrata*, which it most resembles. The maxilla is very similar to *E. rostrata*, and the mandible is similarly like, except that the inner tooth of the chewing end is much longer and sharper. The absence of a crest and the symmetrical genital segment and spines of the basal joint of the fourth feet differentiate it from *E. pulchra* ♀.

The larger size and number of bristles on the endopodite of the posterior antennæ and smaller number of spines (or triangular lamellæ) on the fourth basal differentiate it from *E. rostrata*, of which, however, it may be a variety. It will be described and figured subsequently.

Two perfect specimens were captured at 300 fathoms.

HETEROCHÆTA ZETESIOS, *n. sp.* ♂

Length 3·5 mm. This Copepod, found in Fowler's Research Collection, was in very good state of preservation, except that the end segments of the anterior antennæ and tail setæ were damaged. The portion of the anterior antennæ left (nineteen joints) reached a length of 4 mm., so that it was much longer than the whole length of the animal. The geniculation occurs between the eighteenth and nineteenth joints. The basal joint of the posterior foot jaw has bristles, but no long spine, and the last two lobes of the anterior foot jaw carry plain hooks not beset with comb teeth. The fifth lobe is very much longer than any of the others, and its hooked bristle is stouter than that of lobe 4, and is quite without teeth or hairs, while that of lobe 4 is beset with fine short bristles. The mandibles, unlike *H. longicornis* (of which it might possibly be the ♂, but the ♂ of this species is unknown), are not alike, the chewing end of one carrying two trifid, one single pointed, and one long, stout, pointed outer tooth (four in all), whereas the chewing end of the opposite mandible carries only two slenderer, long, pointed teeth. The exopodite of the mandible carries four extraordinarily long and densely feathered bristles, the endopodite is well developed. The last joint of the outer branch of the fourth feet is of similar form to that of the third foot. The fifth feet are unlike those of any known Heterochæta, the second basal of the right foot being produced into a long comb-like process with stiff, short bristles on the inner margin, the first segment of the exopodite is small, the second very large and very broad with the internal margin armed with two protuberances, one having a series of short teeth, the other and distal one armed with a few stiff bristles. The second basal of the left foot has a rounded and projecting distal inner margin armed with stiff bristles. The bristles of the posterior antenna are of great length and densely feathered.

In size, length of anterior antennæ, characters of the basal joint of the posterior foot jaw, and of the anterior foot jaw, and normal shape of the third segment of the exopodite of the fourth foot this Copepod resembles *H. longicornis* (Giesb.). The ♂ of this species is, however, unknown, and the example under notice may possibly be this, or a new species. Provisionally I name it *zetesios*.

PLEUROMMA ROBUSTUM, *Dahl.*

Many examples of this Copepod have been captured in my Faröe tow-nettings, and I found several examples of it in Fowler's Research Collection. The ♀ averages 4 mm. length, the ♂ 3·5–3·7 mm. The pigment spot is always on the right side of the body, and the clasping antenna on the left. The teeth of the anterior antennæ are small, and both the second feet have excavations and teeth on the first segment of the internal branch. The abdomen is quite symmetrical. Dahl remarks of this species that though found in tropical areas of the ocean singly and in deep water, it has a wide distribution, and in northern regions comes nearer to the surface, having been once taken in the vertical net from 100 metres to the surface. I have taken it several times in the closing net at 100 and 150 fathoms.

THAUMALEUS LONGISPINOSUS ♂.

Only the ♂ of *Th. longispinosus* and *Th. thompsonii* are known, and the furca of the former has four bristles, while that of the latter species has only three. If the tail bristles are to be regarded as of constant diagnostic value, this specimen approaches more nearly to *Th. longi-*

spinosus in the possession of four furcal bristles. The whole length of my specimen is 1·19 mm., and the relative length of abdomen to cephalothorax is as 1 to 4, somewhat different from Giesbrecht's measurements, making the body in the Shetland specimen larger in proportion. *Thaumaleus longispinosus* was taken by Bourne at Plymouth in 1890, and *Th. claparedii* by Scott in 1889 in the Firth of Forth, and by Thompson in 1889 in Liverpool Bay; but so far as I am aware no Thaumaleus has been captured so far north as Shetland before.

AUGAPTILUS ZETESIOS, *n. sp.* Plate III.

Total length 4·71 mm., of moderate transparency. Head separate from thorax, with weak rostrum situated on a papilla. Abdomen three segments, the genital longer than both the others together. Furcal segment four times as long as broad. Anterior antennæ of twenty-five segments, and reaching considerably beyond the end of the furca. The outer branch of the posterior antennæ is a little the longest. The hairs of the outer branch are very long and feathered; those of the other branch shorter and naked. Mandibles have a long and thin chewing end with two large and one very small teeth. Maxillæ have all the outer and inner lobes except the first (of each) suppressed. The bristles are of very great length. The bristles of the second basal and endopodite of the anterior foot jaws carry two series of the peculiar "hutpiltzformigen Anhange" characteristic of Augaptilus (see Fig. 12). In the posterior foot jaws the bristles of the endopodite are similarly armed. The swimming feet have each three segmented inner and outer branches. The outer spine on the first segment of the exopodite of the first foot is very long and closely haired, and the distal segment carries two long tapering naked bristles. In the second and third pairs the long bristle on the second basal (which is present in the fourth feet) is absent. The third segments of the exopodites of the second, third, fourth, and fifth feet have a very convex outer margin, and the spines are very rudimentary. The bristles at the end (especially in the third and fourth feet) are stiff and curved inwards, with long hairs on the inner aspect, and short stiff hairs on the outer. The fifth feet have a rather longer (proportionally) endopodite, and the last joint of the exopodite is shorter than in the second to fourth pairs, while the distal segment of the inner branch is comparatively longer than in the other feet. The second segment of the outer branch carries a long, stout (at the base), and tapering spine nearly as long as the joint and armed on the inner side with stout teeth from the base to the distal end, and many short teeth on the surface and a few stout teeth on the outer proximal margin. This Copepod bears some resemblance to *Aug. longi-*

caudatus, Giesb., but is considerably larger. The genital segment is longer than both succeeding segments; the anal segment is half as long again as the middle segment of the abdomen. The bristles of the mandible and anterior foot jaws, and the proportions of the joints of the posterior foot jaws, also differ. The fifth foot differs in relative proportions, and the spine on the second joint of the exopodite is quite peculiar. It differs from *Aug. megalurus*, especially in the large spine of the fifth foot and the size of the middle segment of the abdomen.

Two specimens were found in Dr. Fowler's collection, one from a bottle marked 19 d.e. Epiplankton, and one from Mesoplankton 20 (stations referred to in his paper in the *Proc. Zool. Soc.*, *loc. cit.*).

PSEUDOCYCLOPIA GIESBRECHTII, *nov. sp.* Plate IV.

Length of the whole animal, ·72 mm. (cephalothorax, ·575 mm.). Body robust, with a short pointed rostrum, and of four segments. Abdomen slender, of four segments, the first equal in length to the third and fourth. Furcal segment about as long as broad—of the four tail setæ, the two middle of each side are stout, not jointed, and cross-ringed in their whole length, and feathered throughout; the four shorter hairs are cross-ringed only to the joint. The *anterior antennæ* do not reach to the end of the cephalothorax, and contain seventeen joints, the first joint about equal in length to the succeeding thirteen joints. The *posterior antennæ* have only one branch (internal) composed of four joints. The *mandibles* are large, with broad chewing end and two-branched palp. The *maxillæ* and *anterior foot jaws* present nothing unusual, except that the exopodite of the former is suppressed. The *posterior foot jaws* consist of two basal joints and a five-jointed endopodite. The two basal joints are about equal in length. The endopodite is shorter than the second basal joint.

The Swimming Feet.—The first pair is short, and has three jointed exopodites and one jointed endopodites; the second pair has three jointed exopodites and two jointed endopodites; the third pair has three jointed outer and inner branches. The internal branch of the right foot is longer than that of the left side, the second segment being longer than that of the other internal branch. The distal joint of the outer branch of the left foot is much longer and broader than that of the foot of the other side, has two stout spines on the outer margin, and a long apical spine twice the length of that of the opposite foot, the terminal joint in which carries only one outer marginal spine and a very short apical spine. The long, stout, naked spine arising from the inner distal margin of the first basal joint is in each foot as long as the internal branch. This foot is very remarkable, and may be an abnormality. The fifth feet are very peculiar, consisting each of one branch only, each of the two basal joints and a terminal joint forming three finger-like projections. The second and in greater degree the third and fourth feet have their segments ornamented on the surface with rows of fine spines, and the joints of the endopodites of the third pair are fringed with spines.

The absence of a secondary branch of the posterior antennæ in this species is remarkable. In other particulars, size and spinulation of the feet segments, number of antennæ, joints, etc., it differs from any known species of *Pseudocyclopia.* I have named it after Dr. Giesbrecht, to whom I showed these drawings when recently I visited Naples. It was captured in the surface tow-net off the island of Bressay, Shetland, in March, 1900.

EXPLANATION OF PLATES I.–IV.,

Illustrating Dr. R. N. Wolfenden's paper on "The Plankton of the Faröe Channel and Shetlands."

Plate I.

1. *Aulographis furcellata* (*nov. sp.*), a needle.

2 and 2*a*. *Aulographis tetrancista* (?) (variety).
  2. A short-branched verticil.
  2*a*. A verticil with long branches.

3. A needle of *Aulacantha scolymantha.*

4, 4*a*, 4*b*. *Aulodendron boreale* (*nov. sp.*).

5. Needles of *Sphærozoum* (*ovodimare ?*).

Plate II.

Challengerida.

1. *Challengeron walwini* (*nov. sp.*).
  1*a*. The peristome in different aspect.

2. *Challengeron balfouri* (?) (variety).
  2*a*. The peristome (enlarged).

3. *Challengeron balfouri* (?) (variety).
  3*a*. The peristome seen dorsally.

4. *Challengeria tritonis.*

5. *Challengeria zetlandica* (*nov. sp.*).
  5*a*. Viewed ventrally.

Plate III.

Augaptilus zetesios (*nov. sp.*).

1. Whole animal, dorsal (2 inch obj. × 5 oc.).
2. Fifth feet (½ inch obj. × 5 oc.).
3. Spine on second segment of exopodite of fifth feet (¼ inch obj. × 5 oc.).
4. Fourth foot (½ inch obj. × 5 oc.).
5. First foot (½ inch obj. × 5 oc.).
6. Second and third segments of exopodite of first foot (¼ inch obj. × 5 oc.).
7. Mandible (½ inch obj. × 5 oc.).
8. Maxilla (½ inch obj. × 5 oc.).
9. Posterior antenna (1 inch obj. × 5 oc.).
10. Anterior foot jaw (½ inch obj. × 5 oc.).
11. Posterior foot jaw (½ inch obj. × 5 oc.).
12. Processes on bristles of posterior foot jaw (⅙ inch obj. × 5 oc.).
13. Anterior antenna (1 inch obj. × 5 oc.).

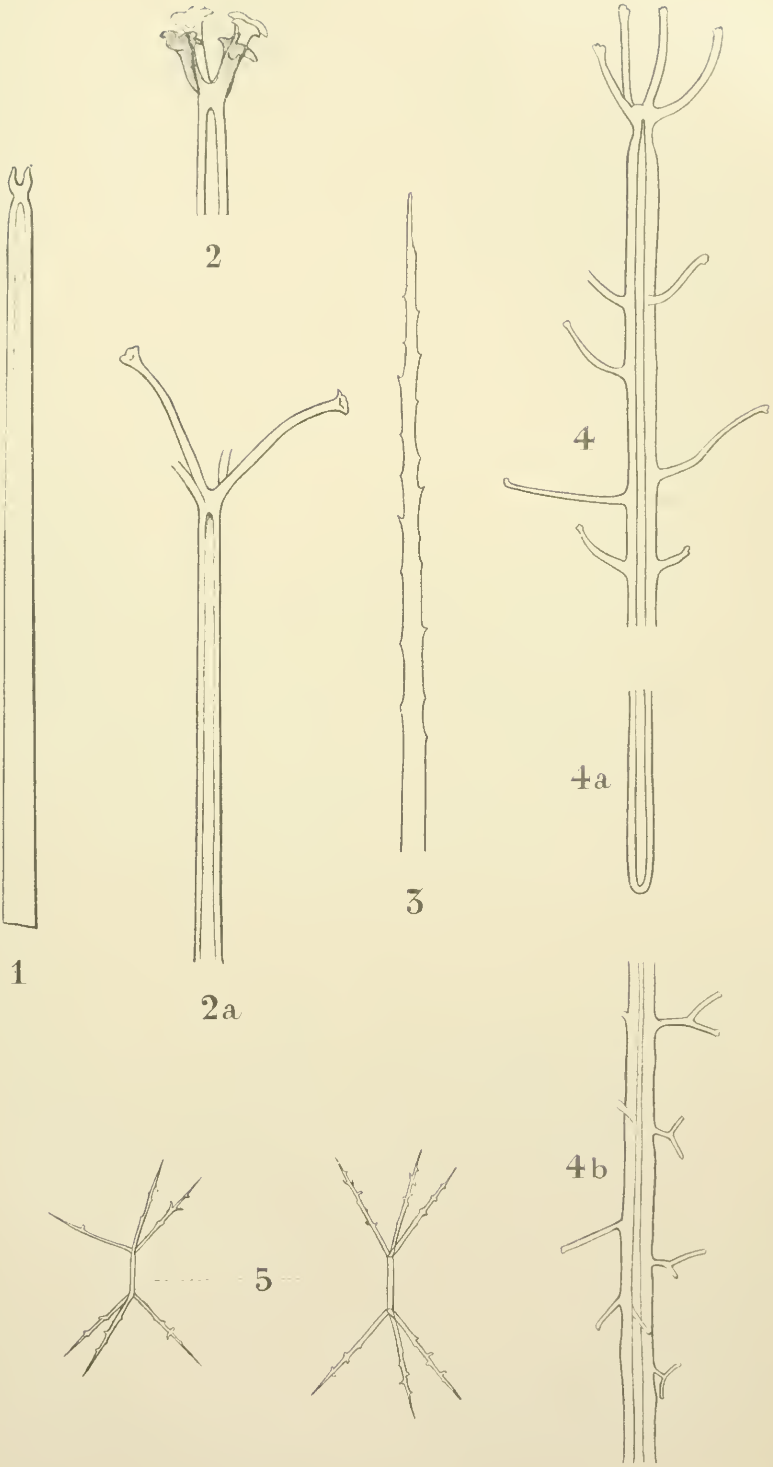
Plate IV.

Pseudocyclopia Giesbrechtii (*nov. sp.*).

1. Whole animal in profile (½ inch obj. × 3 oc.).
2. Abdomen, dorsal view (¼ inch obj. × 5 oc.).
3. First foot, dorsal view (¼ inch × 5 oc.).
4. Third feet, ventral view (¼ inch × 5 oc.).
5. Fourth foot (¼ inch × 5 oc.)
6. Second foot, dorsal view (¼ inch × 5 oc.).
7. Fifth feet, dorsal (¼ inch × 5 oc.).
8. Anterior antenna.
9. Posterior antenna.
10. Mandible.
11. Maxilla.
12. Anterior foot jaw.
13. Posterior foot jaw.

(All ¼ inch obj. × 5 oc.).

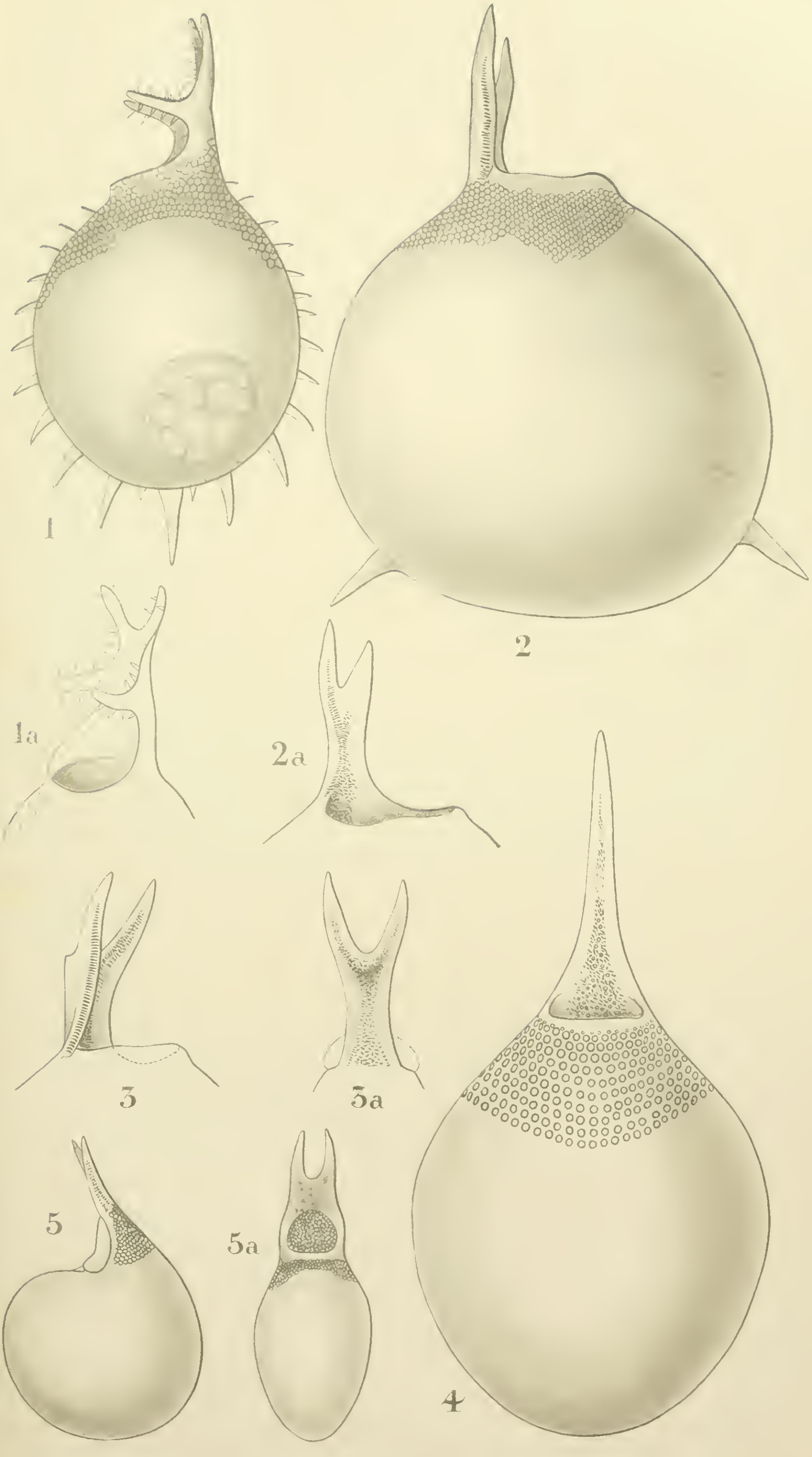
Plate I


2
1
2a
3
4
4a
4b
5

Drawn by Marion Lees

Bale & Danielsson Ltd.

Plate II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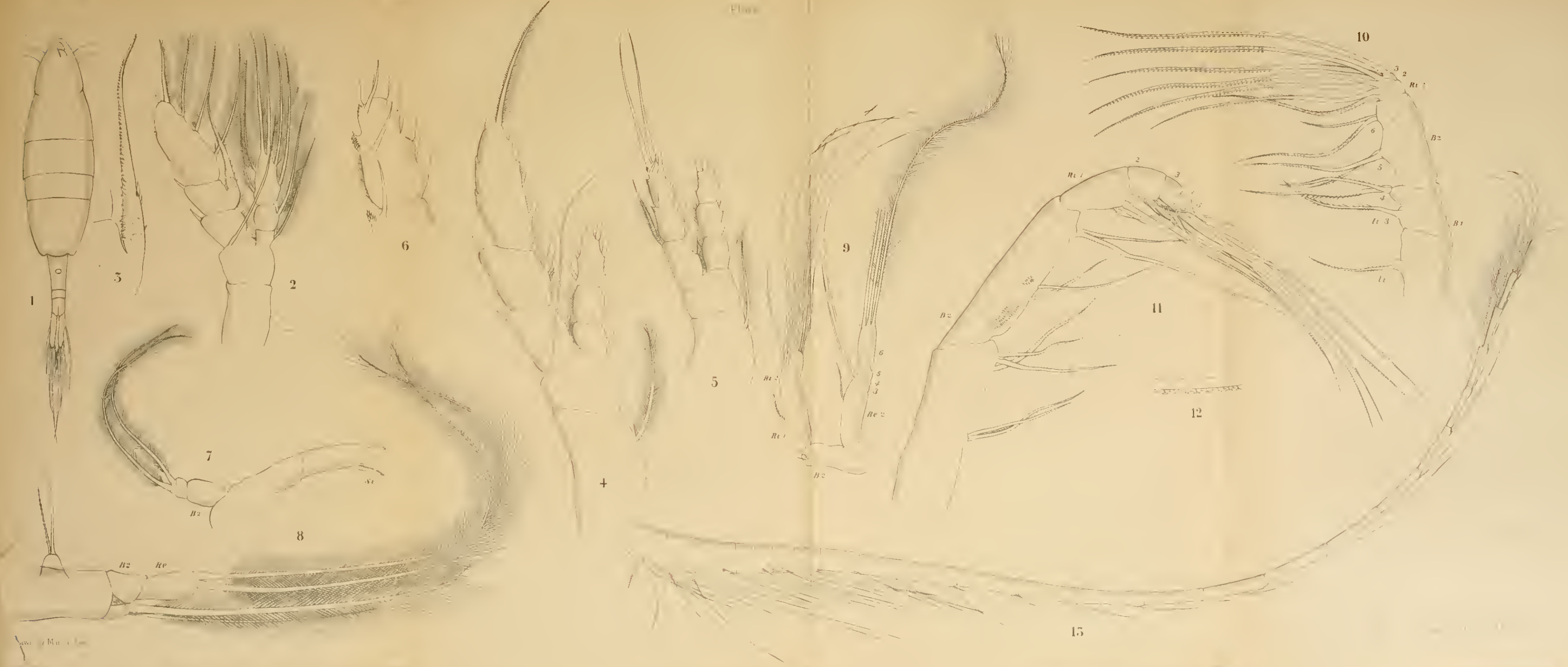
5a

Drawn by Marion Lees

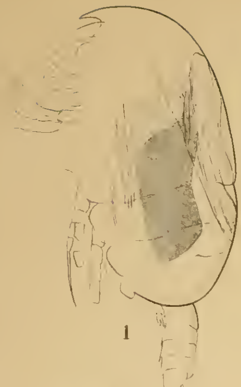
Bale & Danielsson Ltd. lith

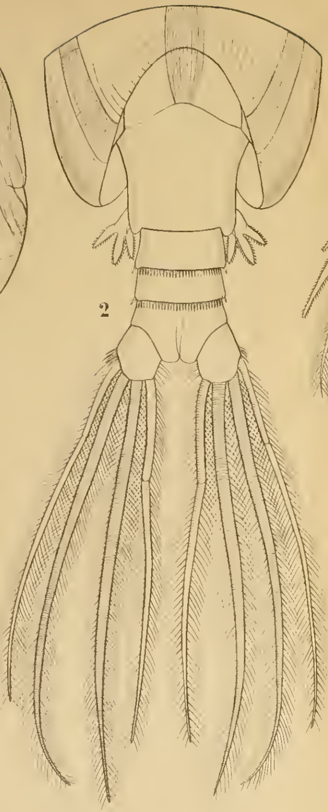
Plate

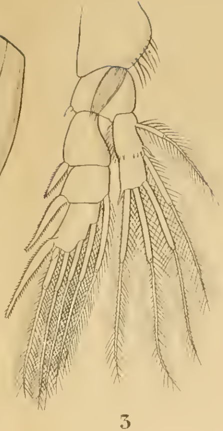


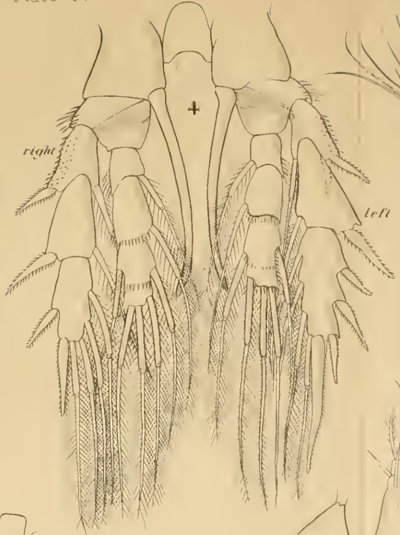
Rt 1
Rt 1
B2
Rt 3
Rt
B1
Rt 2
Rt 1
Re 2
B2
Rt
B2
B2
Re

Plate IV





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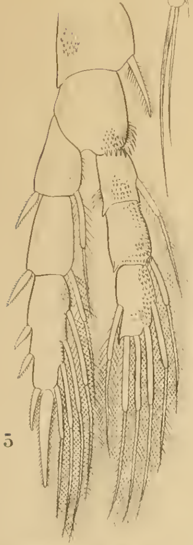
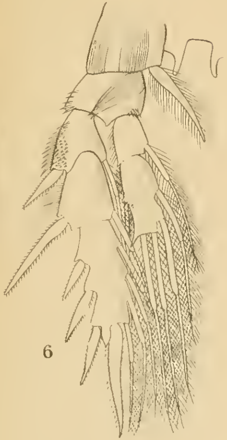
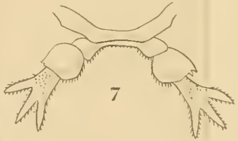
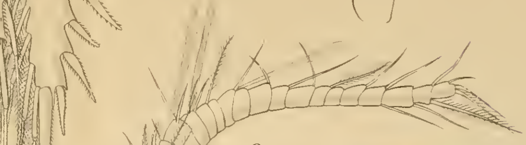
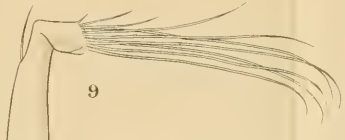
left

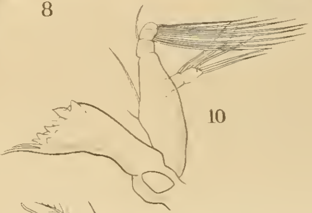


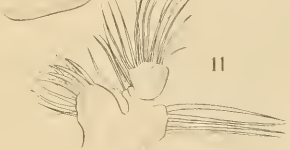


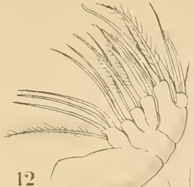


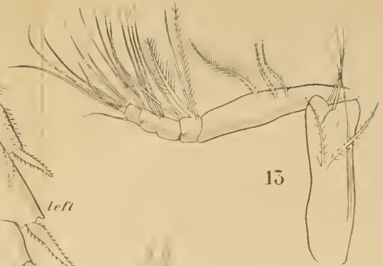












The Periodic Growth of Scales in Gadidæ and Pleuronectidæ as an Index of Age.

By

J. Stuart Thomson,

Lecturer on Biology, Municipal Technical Schools, Plymouth.

(With Plate V.)

THE first part of a lengthened and detailed statistical paper on the structure and seasonal growth of Gadoid and Pleuronectoid scales will shortly be issued from the Marine Laboratory.

The forthcoming paper will show by means of tabulated statistics that scale growth is accelerated during the warmer season of the year; but diminished during the colder season in such a methodic manner as to cause the formation of annual rings. The formation of these annual rings results from the fact that the lines of growth on the scale surface are comparatively widely separated from one another in that portion of the scale formed during the warmer season of the year; but much less widely separated in that part built up during the colder season. Thus by following the arrangement of the lines of growth on scales, it is a simple matter to observe the starting place of any year's growth by the comparatively wide separation of the growth-lines at that portion of the scale, and in this way the surfaces of scales appear mapped out by annual rings. These annual rings supply us with an index as to the age of the fish, and may be roughly compared to the rings in many trees. The annual rings in the stems of trees are due to seasonal nutritive conditions, and the rings on the scales of fishes are probably the result of seasonal environmental conditions such as food, temperature, etc. In more detail, the alternate occurrence of comparatively rapid and slow areas of growth in scales is probably the result of the variations in food, temperature, etc., which are associated with the alternation of summer and winter. For example, the abundant supply of food (plankton, etc.) during the warmer season of the year probably has much connection with the comparatively rapid growth of the scale at that time as compared with the slow increase during the colder season, when there is a decrease in the supply of food.

These facts appear to possess both scientific and economic importance, since they permit the extension to marine fishes of a new system of age determination by means of these annual rings on scales, a system which has recently been shown and demonstrated by Dr. Hoffbauer for the carp.*

I hope to illustrate clearly the mode of formation of annual rings in Gadoid scales by the aid of the figure on the accompanying plate.

The figure (Plate V., Fig. 1) represents the scale of a pollack, 28·5 centimetres (11½ inches) in length, captured towards the end of October. A minute translucent area (see Fig. 1, C) devoid of any lines is situated towards the narrower and more internal end of the scale; and around this area, which is the first portion of the scale to be formed, are grouped numerous excentric lines of growth similarly disposed to the excentric layers in the starch grains of the potato.

The excentric lines of growth on this scale, however, are arranged in such a manner (see figure) as to map out its surface into two main regions, namely, an internal area, which is the entire growth of the first year, and an external part, the summer growth of the second year. One understands how these two areas appear so distinctly if one follows the lines of growth outwards from the translucent area to the broader and more external part of the scale. One may firstly observe that there are nineteen lines comparatively widely separated from one another, which indicate the growth of the first summer, and secondly, ten lines less widely separated, indicating growth of the first winter. External to these, there follows an area showing much more widely separated lines of growth, which indicate the scale growth of the second summer.

The difference between the lines of growth formed during the second summer and those of the preceding winter is so apparent as to clearly define the termination of the first year's growth. The widely separated lines of the second summer number nineteen, and as the pollack from which this scale was taken was captured in October, it appears that in this scale the number of lines formed during the second summer exactly agrees with the number formed during the first summer.

In most cases, however, the growth of the scale in the pollack's second year appears to be greater than that of preceding and succeeding years. As the statistics of the forthcoming paper are too detailed for the purposes of this note, I select a few tabulated figures relating to *Gadus pollachius* and *Gadus minutus*, which will in some measure show the general bearing and object of this work. The following tables commence with fish about an inch in length, the scales of which show a small translucent area without any lines of growth (excentric lines),

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* "Die Altersbestimmung des Karpfen an seiner Schuppe," von Dr. Hoffbauer; *Jahresbericht des Schlesischen Fischerei-Vereins für das Jahr 1899.*

Plate V.

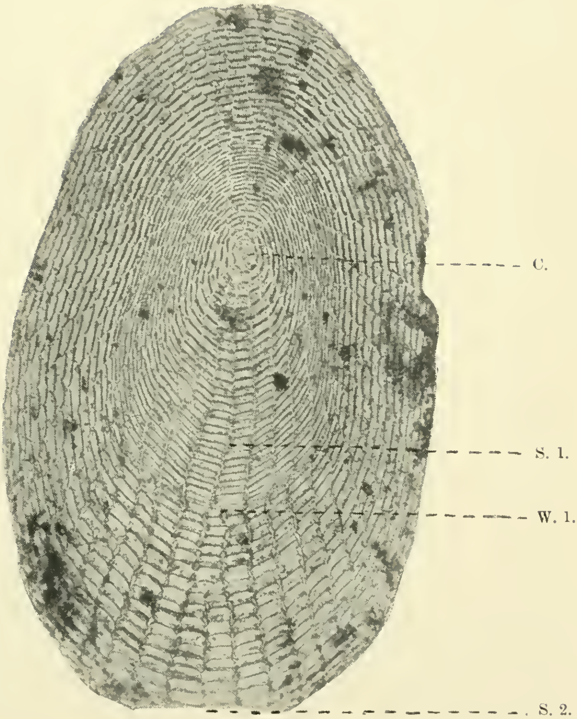

Fig. 1. Microphotograph of pollack scale at end of second summer. (Magnified 45 diameters.)

C. = Centre of growth.
C.—W. 1. = Growth of first year.
C—S. 1. = Growth of first summer.
S. 1.—W. 1. = Growth of first winter.
W. 1.—S. 2. = Growth of second summer.

and terminate with a pollack apparently at the commencement of the ninth summer. By means of these tables a comparison may be made as to the number of lines of growth (excentric lines) formed during successive years.

GADUS POLLACHIUS.

No. of fish.	Length of fish.	Date (month of capture).	No. of annual rings.	No. of lines of growth (excentric lines in years. I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
2	2·3 cm.	May	0	0	—	—	—	—	—	—	—	—
4	4–6 ,,	July	,,	2–4	—	—	—	—	—	—	—	—
3	6–7 ,,	,,	,,	3–5	—	—	—	—	—	—	—	—
6	9–10 ,,	Oct. to Dec.	1st forming	13–16	—	—	—	—	—	—	—	—
9	10–11 ,,	,,	,,	15–19	—	—	—	—	—	—	—	—
2	11–12 ,,	December	,,	15–19	—	—	—	—	—	—	—	—
2	35–39 ,,	April to June,	2 complete	23–24	30–31	7	—	—	—	—	—	—
1	45 ,,	April	3 ,,	21	29	18	2	—	—	—	—	—
1	60 ,,	,,	4 ,,	24	24	18	22	3	—	—	—	—
1	84 ,,[*]	June	8 —	26	25	12	12	11	9	11	10	3

[*] In this case the majority of the scales showed much disintegration.

GADUS MINUTUS.

No. of fish.	Length of fish.	Date (month of capture).	No. of annual rings.	No. of lines of growth (excentric lines). Year I.	Year II.	Year III.
1	3·3 cm.	June	0	0	—	—
8	3·4–5 ,,	,,	,,	2–7	—	—
17	5–6 ,,	,,	,,	3–9	—	—
8	6–7 ,,	,,	,,	6–10	—	—
3	11–12 ,,	July	1 complete	27–33	6–10	—
6	12–15 ,,	,,	1 ,,	23–32	9–12	—
2	19–20 ,,	Not known	2 ,,	19–25	20–25	10–15

From the preceding tables the age-indices of these varied sizes of *Gadus pollachius*[†] and *Gadus minutus* may be tabulated as follows:—

GADUS POLLACHIUS.

Length of fish.	Age of fish.
2–7 cm.	First summer
9–12 ,,	First winter
35–39 ,,	Third summer
45 ,,	Fourth spring
60 ,,	Fifth spring
84 ,,	Ninth spring (?)

GADUS MINUTUS.

Length of fish.	Age of fish.
3·3–7 cm.	First summer
11–15 ,,	Second summer.
19–20 ,,	Third summer

In conclusion, I would express my indebtedness to the officials of the Marine Biological Association, more especially to Mr. Walter Garstang, Naturalist in Charge of the Fishery Investigations.

[†] Compare CUNNINGHAM, *Marketable Marine Fishes*, 1896, p. 295.

Notes on Plymouth Sponges.

By

George Bidder.

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(1) Sycon compressum:

On a Specific Character.

Sycon compressum is one of the long-recognised sponges, that stand refreshingly conspicuous in a group made difficult with doubtful definitions. The unique dermal spicules, and the striking outward form, divide it from other species in a way quite different from that in which *Sycon raphanus* is divided from *S. villosum* or *Reniera cinerea* from *Reniera permollis.*

From the doctrine of evolution it would appear the logical deduction that the constant and striking differences which *S. compressum* shows from its next allies are important to its existence, while the varying differences shown among other so-called species are nearly, or quite, uninfluential. It therefore seems worth while to examine whether we can find circumstances in the life of the sponge which can lift this statement from the deductive to the empirical standpoint, by showing that there are exceptional facts in the environment, to which the unusually marked specific characters exceptionally fit the animal.

Walking on the low-tide rocks immediately under the Laboratory at Plymouth, it will be found that there occur in abundance *S. compressum, S. ciliatum, Leucosolenia botryoides, Guancha coriacea, Halichondria panicea,* and *Hymeniacidon sanguineum.*

In the tide-pools all four calcareous sponges occur in quantity, and under heavy masses of weed both the Sycons are equally abundant. But on the tops of all the naked rocks we find able to support existence only the green tufts of *Halichondria*, the red smears of *Hymeniacidon*, and the crisp little white leaves of *S. compressum.*

Both the siliceous species are comparatively massive incrusting sponges, and therefore exist under completely different conditions to the delicate, bag-like, Calcarea. Leaving them, therefore, for the present, we find, with respect to two closely allied sponges, that *S. compressum* and *S. ciliatum* live side by side in every sheltered cranny, but on the working tops of the rocks *S. compressum* is alone—

often with little even of seaweed hardy enough to bear company—exposed for hours every day to sun, rain, or wind.

I made some tentative experiments as to the endurance of *S. compressum*, a brief summary of which, with figures of the metamorphosed collar-cells, appeared in "The Collar-cells of Heterocœla," *Q. J. M. S.*, vol. 38. Though they would have been better if comparative with studies on other species, the results by themselves are fairly striking.

(1) Several sponges were gathered at 1 p.m. on February 6th at low neap tide. They were taken from positions on the tops of rocks, free from all water or seaweed, and placed, without more water than they contained, in a small empty corked bottle. On February 7th, at 1 p.m., a section from a large specimen was examined under the microscope; though twenty-six hours out of the water, flagella were moving everywhere (though not quite on all cells). The absence of collars and hemispherical outline of the cells has been described in the paper referred to. The remainder of the sponge was placed in the aquarium circulation, and on February 8th, at 6 p.m., was found in the most healthy life, most of the cells being collared and perfectly normal in shape, while the flagella were in active motion.

(2) Some of the same collection were taken from the bottle at 8.30 p.m. on February 7th and placed in sea-water, having endured some thirty-four hours' sojourn in air. Another experiment being designed, the sea-water was saturated with indigo-carmine, was out of the circulation, and through a disconnection of the tubes was most of the time entirely without aeration. Notwithstanding that these circumstances were most unfavourable to recuperation, one of the sponges examined at 4 p.m. on February 8th showed a fair proportion of collars, had very active flagella all over, and looked exceedingly healthy; another examined on February 10th, though having no collars, showed healthy flagellate action everywhere. Of the four other specimens treated in the same way and examined on these two days, only one (on February 10th) was found to be completely dead.

(3) Some sponges were collected from the upper and exposed surfaces of rocks, where rain had been falling on them for three hours. They were placed in a dry bottle and, after a further three hours, examined with the following results:—

(*a*) Possibly dead; no changes recognisable; all the cells amœboid in form.

(*b*) Flagellar action observed and (?) the regeneration of a collar.

(*c*) *Violent* flagellar action. This sponge was only just dipped in the sea-water before cutting, (*a*) and (*b*) had lain in sea-water some minutes.

(*d*) Held under a stream of fresh water some minutes, tissues all destroyed.

(*e*) One minute lying in fresh water, of which for thirty seconds it was entirely submerged; a few flagella were found moving, in most parts they were not visible, in most places the cells had thrown out strings of protoplasm, and were in other ways altered.

Though improbable, it was logically conceivable that the comparative immunity to rain and other fresh water was due to modification of the naked protoplasm itself. While (*c*) was in full action, therefore, a drop of fresh water was introduced under the cover-slip. For a moment the flagella quickened, almost instantly stopped, and within a few seconds the cells successively became transparent, then ovoid, then disappeared.

It appears to be fairly certain, therefore, that this apparently fragile member of a singularly delicate group of animals must have some exceptional provisions, (1) to resist evaporation, (2) to withstand injury from such evaporation as still takes place, (3) to resist the entrance of noxious fluids, *videlicet* pure water.

To meet (1) and (3) I propose at once the spicules. Dendy, in his masterly review of the Heterocœla,* pointed out the anomalous position of *S. compressum*, in having a highly developed cortex and yet retaining what may be called the "conal acerates," that is, the centrifugal bunch of unbranched spicules which surmounts the end of each radial tube. The first, as he shows, is a Grantiad character; but the second is typically Syconid.

Now I suggest that the thick, continuous, cortex, set with its dense mass of club-shaped radial spicules, enables the sponge to pursue its daring existence; clothing it with a deep armour of calcareous mosaic through which, when the skin is contracted on its pores, a minimum amount of permeation or evaporation can take place. The shillelagh-like outer ends of the spicules serve, like the heads of iron nails set in a pile at sea, to cover and protect the surface of the substance in which their points are embedded.

As to (2). The danger to a sponge from evaporation of the contained water comes at a stage short of desiccation. If we suppose a rigid, cylindrical, Sycon to be exposed to the sun and wind for two or three hours between tides, the returning water would find it—though perhaps damp, and still in cellular life—with its gastral cavity empty; evaporation having replaced the liquid reservoir by a bubble. Such a sponge is doomed. It has occurred to me again and again, when measuring the oscular currents, to be surprised at the sudden quietude of a *Leucandra* or other sponge employed, after being transferred from one basin to another; a quietude at once replaced by the accustomed stream when the obstructing bubble was removed. This was accomplished in very wide-mouthed sponges by merely raising the osculum, but in most of those dealt with, the bubble could not escape without the aid of pressure.

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* *Q. J. M. S.*, vol. 35.

Hence the flat form of *S. compressum*. In its cloaca a bubble is never formed. The tide leaves it with rounded outline, so that in a sponge a centimetre wide, its shorter axis may be nearly half as much. As there occurs evaporation, even from its protected surface, into the air round it, and the fine capillaries of its walls suck in fresh supplies of water from the central drop, the sides gradually come nearer, like the capsule surfaces of an aneroid barometer, until the cloacal cavity may attain itself such capillary dimensions that only very dry air can further extract the moisture.*

As a matter of observation, above the rising tide it is easy to observe on every side flat, yellowish, sponges, like oval pieces of whitey-brown paper, which swell out at once in water to their natural rounded form; and if a sponge in the rounded form be taken from the water and laid on blotting paper, it becomes flat. On the other hand, in tide-pools which never dry I have found several specimens of *S. compressum* with the oscular part of the cloaca cylindrical, and this observation only corroborates one noted long ago by Grant.

The cylindrical form is never met with on exposed sites. One such specimen was found, not in a pool, but hanging under a large rock, down which, from weeds and growth of all sorts, a trickling of sea-water kept up through the whole period between tides. There was a constantly renewed drop falling from the open cylindrical mouth, and when this was dried away with a handkerchief the sponge could not flatten, like those accustomed to be dry in every ebb, but its stiff round tube remained open and empty.

Among all the Calcarea, the only sponge that I know described of absolutely comparable shape is *Sycortis lingua*, Haeckel (Newfoundland), which appears to me a near connection of *S. ciliatum*. Haeckel notes that only two sponges have dermal spicules at all comparable with *S. compressum* for size and arrangement; the one is *Leucandra lunulata* (Cape of Good Hope), which takes the form of "plattgedrückte langliche Schlaüche"; the other is *Ascandra falcata* (Adriatic), apparently cylindrical.

As to the siliceous companions of *S. compressum*, their complicated, and massively "spongy," structure opens up a totally different series of needs and adaptations, not comparable with the delicate simplicity of the Sycon. One point only may be noted; that for *Halichondria* with its few wide oscula, the difficulty with the contained bubble is slight, and when the oscula point upwards it will escape at once. I am somewhat of opinion that the hairy coat of *S. ciliatum* may assist it in another way to retain moisture, when, in its intermediate situation, hanging under sheltering masses of damp seaweed; it is worth noting that *S. lingua*, from Haeckel's description, has no cortex, but a very long fur.

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* In the drying of marine organisms the external deposit of salt, and internal concentration of brine, must considerably retard ultimate desiccation; though probably with injurious results to organisms whose protoplasm is not adapted to withstand such salinity.

It would involve far more space and detailed discussion than are here convenient to endeavour to assign the exact importance of the few facts above narrated, nor until associated with many parallel observations is it worth while. The subservience of a "marked species characteristic" to outward circumstances, shown in the partly cylindrical form of tide-pool specimens, may be due to the fact that only here such varieties can survive, may indicate a power of individual adaptation. Probably it means merely that mobility, never exercised, is lost; and that the spicules which are never called on to slide over one another become locked and plaited to the rigidity of other Sycons. I have before now endeavoured to show * that the definite series of changes in canal-system and outward form, with which homoplasy presents us again and again in every group of Porifera, bring definite increasing mechanical advantage. Here I have attempted to argue that the most definitely characterised common species of sponge has the most definite use for its species characters. I hope later to be able to show, in the case of *Reniera*, that the minute spicular changes which fill our classifications, and to which it appears impossible to ascribe utilitarian value, are not characteristic of species, but merely the direct consequence in the individual of some altered physical conditions of the nutrient medium.

(2) Halichondria panicea; Suberites domunculus:

VARIATION AND METAMPY.

The specimen of *H. panicea* given me from Exmouth (*vide* p. 317) differs markedly from a Plymouth specimen, or from Bowerbank's figures, in having the interior skeleton far looser and more fibrous in character. The Exmouth specimen shows, even in the innermost mass, numerous well-marked bundles, three or four spicules in thickness, branching, but having a general tendency to parallelism. The Plymouth specimen shows the confused skeleton recognised as characteristic by all authors; and the far more numerous spicules form, in the interior of the sponge, an irregular criss-cross, rarely showing well-marked fibres; looking like a felt of pine-needles, and well represented in Bowerbank's figure (Fig. 300, *Mon.*, vol. i.).

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* *Loc. cit.*, p. 18, and *Proc. R. S.*, vol. 64, p. 61.

This difference is explained when we consider the difference in conditions of life: the Exmouth specimen living some fifteen feet below low-water mark, removed from the possibility of any shock or jar; the Plymouth specimen between tidemarks, exposed to what is often a very violent surf. Such a loose framework as is found in the Exmouth specimen, being very slightly bound together, will dislocate under shocks, and the (sharply pointed) needles drive over one another to form the smaller, and denser, skeleton which is best known to shore-collectors.

I have found a difference, closely comparable to that between the deep-water *Halichondria* of Exmouth and the surf *Halichondria* of Plymouth, in *Suberites domunculus.* In this species the individuals carried on the back of a hermit-crab have a dense skeleton, like the surf-beaten *Halichondria,* and justify their name with a consistency almost of cork; while the individuals found growing on rock in the deep waters of Millbay Channel (Plymouth Sound) are much larger, supported by a skeleton of precisely similar elements, but much looser, giving the sponge the soft consistency of a ripe plum.

If the above explanation be correct of the differences between the soft and hard specimens of *Suberites* and *Halichondria,* the soft *Suberites domunculus* is not a "variety" in the sense that an albino rabbit, or a six-toed cat, is a variety. I am not aware of any word applicable to describe a definite difference from the type, frequently encountered, but known to be due to post-natal influences. It appears useful, in instances where such a history can be proved, to have a word to distinguish the phenomena from those of congenital difference—to distinguish conditional from germinal variation. I suggest the unscholarly, but manageable word, "metamp," suggested by the Greek μεταμπέχομαι = "to put on a different dress." Thus we shall speak of "*Suberites domunculus* met. *mollis*"; and distinguish the inherited darkness of the Cinghalese from the metampic brown of the tropical Englishman. Holding, as I do, that the sizes and forms of sponge spicules are largely influenced by the temperature and constitution of the sea in which they grow, I believe that not only varieties, but many so-called species of sponges, are merely metamps of each other.

To speak of "abnormal forms" does not meet the case—neither the tidal nor the deep-water *Halichondria* can be considered abnormal. The determination of a normal form would, on the view here put forward, mean merely the determination of a normal depth, a normal salinity, or a normal temperature. In the case of littoral and sublittoral species such a determination would in many cases be quite meaningless.

The cylindrical *Sycon compressum*, referred to in the previous note, may be considered a metamp of the flat *Sycon compressum*. In this case the flat form may be considered normal, since according to present knowledge it is a thousand times more frequent. Vosmaer (*Mitt. aus d. Zool. Stat. z. Neapel*, vol. v. part 3) has put forward the view that *Leucandra aspera* is extraordinarily diverse according to its habitat, and my own work has caused me to take the same view of *Sycon raphanus* (cf. the papers cited in previous note); these are cases of mutual and probably continuous metampy, where a normal form is difficult to select.

The skin of *H. panicea*, with its net of spicules, is well represented in Bowerbank's figure (*Monograph*, vol. i. Fig. 505). It is coherent and easily detachable, and, as Ridley and Dendy remark (*Challenger Mon.*, p. 15), Schmidt's definition of his genus *Pellina* is completely fulfilled by this species. Topsent, however, has since (*Réforme dans la Classification des Halichondrina*) revived the genus *Pellina*, with a Renieran instead of a Halichondrian skeleton.

The skin is considerably thicker and more spicular in the Plymouth than in the Exmouth specimen, being conspicuous in spirit as a white veil over the sponge, showing as a hard white line when the sponge is cut. It is tempting to connect this denser spicule-sheathing of the tidal sponge with the restraint of evaporation and protection of soft tissues against brine and rain-water, as suggested in regard to the club-spicules of *S. compressum*; but it must be remembered also that far denser crusts are well known in other siliceous genera which are not tidal.

Bowerbank's Fig. 300 does little justice to the subdermal space. This is not a series of spherical lacunæ in the tangle of spicules; the spicules in the ectosome of *H. panicea* are as definitely arranged as in an *Axinella*. The skin is only connected with the body by spicule-fibres, which traverse the subdermal space like the columns in a Norman crypt, expanding above to support the tangential spicules of the skin, and below to root in the body.

Notes on the Young of *Blennius galerita*, L.

(Montagu's Blenny).

By

L. W. Byrne.

No description of the young of this species seems to exist, with the exception of that given by Emery (1) of some examples from Naples.

The specimens here described were captured at Newquay, on the north coast of Cornwall, in September, 1898, and have been preserved in formol. They were caught in sandy pools surrounding or surrounded by rocks in the shelter of which they seemed to be fond of lying. When disturbed they darted with considerable rapidity from place to place, and in doing so were seemingly assisted by the large pectoral fins which were carried nearly at right angles to the body by the fish when at rest.

They exhibit the large pectoral fins typical of the young of many British species of *Blennius*, but in other respects generally resemble the adult in form. Although these specimens exhibit a remarkable amount of individual variation and show a considerable lack of uniformity in growth and development, the presence of the interorbital "helmet," taken in conjunction with their comparatively small size and radial formula, seems to be diagnostic from a length of 15·5 mm. (including caudal fin) upwards.

A brief description of the Cornish specimens follows.

Length.	Length with middle caudal rays.	Depth of body.	Length of head.	Length of pectoral.	Pectoral compared with length of body.	Averages.
13	15·5	—	3	4·5	·35	·352
13	15·5	2·75	3	4·75	·37	
13·25	15·75	—	3	4·5	·34	
13·5	16	—	3	4·5	·33	
13·5	16	2·75	3	5	·37	
14·25	17	2·75	3·25	4·75	·33	·33
14·5	17·25	3	3	5	·34	
14·75	17·5	3	3·5	5	·34	
14·75	17·5	3	3·5	4·75	·31	
15·5	18·75	3·5	3·5	5	·32	·32
17·5	21	4	3·5	5	·29	·29

Fin-rays. D. xiii. 15–16; A. 18–20.

Pigmentation. At 13 to 13·5 mm. (15·5 to 16 mm. including the middle caudal rays) the caudal peduncle is still quite or almost devoid of pigment. The pectoral fin is more or less thickly covered with a variable number of black chromatophores, and there are a few others at the base of the caudal fin and in a roughly horizontal band on the anal fin.

There is a varying amount of diffuse brown pigment, more especially (*a*) on the upper part and front of the head, (*b*) in a band running from the eye to the upper jaw, (*c*) on the operculum and base of the pectorals, and (*d*) on the body. In the latter situation it is most noticeable (i.) in four more or less faint V-shaped markings on each side of the dorsum, the first below the origin of the dorsal fin and the third below its lowest point, and (ii.) in more or less indefinite patches below and alternating with these.

A considerable number of dark brown chromatophores (very probably black chromatophores seen through the diffuse brown pigment) are scattered along the dorsum on each side, along the base of the anal fin, and, less freely, on the trunk; in some cases similar chromatophores may be detected among the diffuse pigment (*a*), (*b*), and (*c*), already mentioned.

At 14·25 to 14·75 mm. (17 to 17·5 mm. with the middle caudal rays) the caudal peduncle is still almost devoid of pigment. A few of the black chromatophores at the base of the caudal fin remain, while those on the pectorals vary much in number, being in some cases many and closely set and in others few and scattered.

The diffuse brown pigment is more marked and more generally distributed, beginning to appear on the dorsal and anal fins and the lower part of the pectorals. There are six V or U-shaped dorsal markings, the last of which is still faint and is situated below the posterior end of the dorsal fin, and alternating with and below these are Λ or Π-shaped markings on the body. The dark brown chromatophores are much less noticeable and more restricted in distribution.

At 15·5 mm. (18·75 mm. with middle caudal rays) the large black chromatophores on the pectoral fin are no longer visible, the body is generally covered with diffuse brown pigment, which extends on to the dorsal, anal, and lower part of the pectoral fins, the dark chromatophores have almost disappeared, and the body markings are much as in the last stage, with the addition of traces of a seventh dorsal band on the caudal peduncle.

At 17·5 mm. (21 mm. with middle caudal rays) the pigmentation remains practically the same, but is more intense.

The *pectoral* fins grow comparatively shorter with age, though subject to considerable individual variation; both these points appear sufficiently in the table.

The *narial tentacles* are plainly visible in all examples from 13 mm. up.

The *interorbital "helmet"* increases with age, but may attain a very different growth in two individuals of the same size. It consists of a single leaf-like and broadish tentacle followed by several smaller ones; these latter seem to vary much in the period at which they appear—though present in one specimen of 15·5 mm. they have not yet appeared in another of 17·25 mm.

A comparison with the figures given by Emery (**1**) of young forms attributed to this species from Naples shows that (in addition to the individual variations above alluded to) there is a very great difference in the development of Atlantic and Mediterranean specimens; a Neapolitan example of 15 mm. (including caudal) shows no trace of the interorbital "helmet" and has far longer pectorals than any of the Cornish specimens, while a Neapolitan example of 23 mm. (including caudal) still retains most of the black pigment on the pectorals, which it is obvious must undergo their comparative reduction in size at a much later period of growth than in the case of the Cornish specimens. The differences in pigmentation and general form do not appear, when allowance has been made for the different methods of preservation, to be very great.

Apparently in *B. galerita*, as in *B. pholis* (**3** and **5**) and *B. ocellaris* (**2** and **3**), the size and dark pigmentation of the pectoral fins increase until a certain stage of growth is reached (possibly the stage at which the young fish first begins to assume the habits of the adult), when this increase is checked and the fins gradually assume the form and colouration found in the adult.

The true significance of the "long-finned" phase of *Blennius* is by no means certain. It has been suggested that it is of an ancestral nature, but if so it is curious that *Anarrhichas* does not appear to pass through such a phase. The groups of *Acanthopterygii* in which the pectorals are most markedly developed are the Trigloids and Scopænoids, forms which are closely allied to one another, but do not appear to be in any way related to the blennies.

If, on the other hand, the large size and dark pigmentation of the pectorals are regarded as a purely transitory and adaptive character, the "long-finned" blenny may be compared with the pelagic stages of certain gadoids (*e.g. Molva* and *Onos*), in which the ventral fins are enormously prolonged and deeply pigmented. It is not much use speculating upon the origin and utility of such a stage, but the observation on *Dactylopterus* mentioned by Holt (**4**) certainly suggests the possibility that the possession of large and darkly pigmented accessory organs may easily divert the attacks of enemies from a defenceless but almost transparent larval fish during the pelagic stage of its existence, and this theory is to a certain extent borne out by the fact that the decrease in size and loss of pigment would appear in *Blennius* to coincide to some extent with the adoption of the habits and colours of the adult.

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On the Occurrence of *Squilla desmaresti* in the North Sea.

By

F. Jeffrey Bell, M.A.

So far as I have been able to discover, there is no record of the presence of this or any other Squilla in the North Sea; to make sure I inquired of Dr. Hoek, whose experience is unrivalled, and he assures me that the only record is that of an *Erichtheus* stage, discovered on the Dogger Bank during the cruise of the *Pommerania* (1872). Early in May (1901) I received through the Director of the Natural History Museum a specimen of Squilla, as to the rarity of which in the Channel he called my attention. It was accompanied by letter A, the writer of which was Lieutenant and Commander G. S. Carr, R.N., C.M.G. I thought the circumstances warranted my writing as I did in letter B, the answer to which (C) is, if I may be allowed to say so, the very pattern of what an answer should be, and another example of the admirable training of our seamen.

I think it may quite safely be said that *Squilla desmaresti* has been dredged in the North Sea; in this, if not in previous centuries—*auspicium melioris ævi!*

(A) H.M.S. "Circe," Harwich, 30*th April*, 1901.

Dear Sir,—By this post I am sending you a specimen for classification. It was trawled up by *May Queen* (R. 32) on 29th about three miles east of the Kentish Knock. I am quite unable to identify it, and should be much obliged if you will give me its name, etc. During two years now in charge of the North Sea Fisheries it is the first specimen I have seen.

(B) Natural History Museum, 3*rd May*, 1901.

Sir,—The specimen sent by you is the Stomatopod Crustacean *Squilla*. I cannot find the Kentish Knock (if I have read it correctly) in our atlases, but if it is in the North Sea I should like to have your assurance that your collector is trustworthy, for Squilla is very rare even off Cornwall, and its appearance in the cold sea of April off Harwich is, I believe, unrecorded, to say the least.

(C) H.M.S. "Circe," *4th May*, 1901.

Sir,—With reference to your letter of yesterday the Squilla was actually taken out of the trawl of the boat R. 32 on the date mentioned. One of my officers saw it when he was boarding her, and the skipper sent it to me, as he said that in all his experience of forty years' trawling he had never seen one like it. The Kentish Knock is a shoal off the Thames Estuary in lat. 51·39 N., long. 1·41 E. The water the Squilla was dredged up in was about twenty-four fathoms. The surface temperature was 52° Fahrenheit at the time.

The Second International Conference for the Exploration of the Sea, Christiania, 1901.

On the invitation of the Norwegian Government a second International Conference met at Christiania in May, 1901, to revise and complete the proposals formulated at the Stockholm Conference in 1899 for a combined hydrographical and biological exploration of the North Sea and adjoining waters in the interests of the sea-fisheries.

The delegates appointed by the various Governments to attend the Conference were as follows:—

NORWAY.—Prof. F. Nansen, Dr. J. Hjort.

SWEDEN.—Prof. O. Pettersson, Prof. P. T. Cleve, Mr. G. Ekman, Capt. E. G. D. Maechel, Dr. F. Trybom, Mr. A. Wijkander.

RUSSIA.—Prof. O. von Grimm, Dr. N. Knipowitsch.

FINLAND.—Dr. O. Nordqvist.

GERMANY.—Dr. H. Herwig, Prof. K. Brandt, Prof. F. Heincke, Prof. H. Henking, Prof. O. Krümmel.

DENMARK.—Capt. C. F. Drechsel, Dr. M. Knudsen, Dr. C. G. J. Petersen.

HOLLAND.—Prof. P. P. C. Hoek.

BELGIUM.—Prof. G. Gilson, Mr. R. Andvord.

GREAT BRITAIN.—Sir Colin Scott Moncrieff, Prof. D'Arcy W. Thompson, Mr. W. Garstang, Dr. H. R. Mill.

The Report of the Conference has recently been issued, and contains minutes of each day's proceedings and the Resolutions of the Conference. A translation of the former and the authorised English version of the Resolutions are given below.

The Programme of Researches is included under the Resolutions. It embodies a comprehensive scheme of investigations designed to throw light on the various problems to which the representatives of the different nationalities attached importance. Prominence has been given to questions concerning the irregular fluctuations in the yield of the line and drift-net fisheries, to the alleged impoverishment of the trawling grounds, and to the destruction of immature (undersized) fish. The physical and biological investigations which the Conference has resolved upon in connection with these matters are minutely detailed in the programme, which is subdivided into sections according to the character of the work proposed. A characteristic feature of the biological programme is its division into obligatory and optional sections—an arrangement which provides the elasticity necessary for so large an undertaking, while adequately safeguarding the international character of the fundamental inquiries. The investigation of the distribution and destruction of immature (undersized) fish forms part of the obligatory programme.

The general idea of the international programme is as follows:—

I. To obtain an accurate knowledge of the seasonal and other periodic changes in the waters of the North and Northern Seas, both as regards the distribution of temperature, salinity, etc., and also as regards the course and distribution of the currents. (Recent scientific observations on a limited scale have rendered it probable that in some years Arctic water, and in others Atlantic water, predominates in the North Sea basin,—changes of such magnitude that obviously the distribution of food-fishes and of other animals throughout this area must be profoundly affected.)

II. To determine the amount of variation in the character and abundance of the food-supply of food-fishes, whether floating (*i.e.* plankton) or on the sea-bed.

III. To determine the variations in the abundance and distribution of food-fishes, both in the egg, young, and adult conditions.

IV. To determine the extent to which these variations are due, either (*a*) directly to natural physical causes; or (*b*) indirectly to the same causes through fluctuations in the food-supply; or (*c*) to the operations of fishing-vessels in modifying the natural conditions of reproduction and growth.

V. To provide other information necessary for the consideration of remedial measures; *e.g.* artificial propagation, effect of special fishing implements, new methods, places and seasons of fishing, size limits.

In order to carry out the international programme each of the participating countries needs its own local organisation and equipment, and a central international office and staff is required for coordinating the work in general under an International Council. Provision for the latter is made in the Resolutions of the Conference

(C, §§ 1–18), but the local arrangements are left to the respective Governments. In this matter the Conference merely draws the attention of each country concerned to the necessity of providing a specially constructed steamer for the scientific investigations (Resolution D). These steamers are to be employed in the regular investigation of predetermined areas adjoining the coasts of the respective countries. As will be seen from the programme (A, § 2), they are to make simultaneous quarterly cruises for the collection of the necessary physical observations, and are to be engaged in the intervals in the fishing and other experiments detailed in the biological programme.

It remains only to draw attention to the fact that the adhesion of the Continental Governments to the Scheme of International Explorations has already been signified, and that the work is announced to begin in May, 1902, at latest (cf. Resolution E).

The decision of the British Government has not yet been announced.

June 10th, 1901.

MEETINGS OF THE CONFERENCE.

ABSTRACT OF THE MINUTES.

(Translated and slightly abridged.)

Monday, May 6th, 1901.

12 noon.—Opening of the Conference in the reception hall of the University of Christiania by His Excellency the Prime Minister of Norway, Mr. Steen.

On behalf of His Majesty the King of Norway, Mr. Steen extended a cordial welcome to the members of the Conference. He said that they were assembled, as all knew, to draw up their final proposals for an international investigation of the North and adjacent seas. Repeated attempts on an isolated footing had been made to solve the problems of the sea and of the manifold life beneath its surface, and only after ripe experience had the different nationalities come to recognise that co-operation in their labours was essential to success. The task before them was not only an intellectual enterprise of the highest order, but also an application of knowledge in the service of the industrial life of society. It might be difficult to help the fisherman to know where to shoot his nets with the same certainty of a harvest as that with which the farmer manipulated his land and crops. Nevertheless, that was their aim; and if it were only approximately realised, sea-fishing would become the object of intelligent management, relieved of the caprices of chance which at present characterised it. Norway long ago took up and had constantly extended the scope of her scientific investigations upon the life and wanderings of food-fishes. The steamer which they had specially built and equipped for these inquiries had proved satisfactory in every way. As a consequence of their first investigations a new outlook had opened up for their fatherland, with its extensive seaboard and its rich fishing-banks: the prospect of obviating disappointments, the loss of time and labour, and the distress which followed in their train.

Repeating his wish that the labours of the Conference might lead to a satisfactory issue, Mr. Steen formally declared the opening of the proceedings of the Conference.

Dr. Herwig (Germany) thanked the Prime Minister for his good wishes, and spoke of the vast scientific and economic importance of the work which the Conference was to take in hand. As regards Germany, he was glad to say that she was contributing to the work not in name only but in deed, the National Assembly having voted both the money necessary for the construction of a special exploring vessel, and also a sum sufficient for the participation of the Empire in the scientific researches for a period of five years.

Prof. D'Arcy Thompson (Great Britain) and Dr. Knipowitsch (Russia) addressed His Excellency on behalf of the other countries represented, and associated themselves with Dr. Herwig's expression of thanks, recognising at the same time the active collaboration of the Norwegians in these scientific researches.

Upon the proposition of Dr. Herwig, Prof. Nansen was elected President of the Conference with acclamation.

Having taken the chair, Prof. Nansen thanked the Conference for the honour they had done him. He proposed to proceed without delay to the nomination of Vice-Presidents, one for each country represented, and for the sake of continuity proposed the re-election of those who had been Vice-Presidents at Stockholm; viz. Dr. Herwig (Germany), Capt. Drechsel (Denmark), Prof. Hoek (Holland), Prof. Pettersson (Sweden), and Dr. Knipowitsch, in the absence of Prof. von Grimm (Russia). As regards England, he proposed to await the arrival later in the day of Sir Colin Scott Moncrieff, Under-Secretary for Scotland. The Belgian delegates had not yet arrived.

These proposals were unanimously accepted.

The meeting adjourned at 1.15 p.m., to meet again at 2.30 p.m. in the reception room of the Grand Hotel, where the business of the Conference would be transacted.

2.30 p.m. Prof. Nansen (Norway) in the chair.

Present: All the delegates except those of Belgium and Prof. von Grimm, who was prevented by illness from attending. The British delegates, Sir Colin Scott Moncrieff, Mr. Garstang, and Dr. Mill, arrived at 3 o'clock.

It was resolved, on Dr. Herwig's proposition, to follow the same order of business as at Stockholm. The President proposed that they should take the Stockholm programme as the basis of discussion, and thought that a division into two sections, for hydrography and biology, would be unnecessary on this occasion. The Conference agreed.

Dr. Herwig (Germany) proposed that they should discuss the biological questions first, as these had been less elaborated than those relating to hydrography, and would consequently demand more time.

Prof. D'Arcy Thompson (Great Britain) approved of this suggestion, and the Conference accepted it.

Upon the proposition of Prof. Pettersson (Sweden), Dr. Hjort (Norway) was elected General Secretary.

Dr. Herwig, on behalf of the German delegates, submitted a draft programme of biological researches for the consideration of the Conference.

The Conference rose at 3.30 p.m.

TUESDAY, MAY 7TH.

11 a.m. Dr. Herwig (Germany) in the chair.

Present: All the delegates except those of Belgium.

The Conference discussed the programme of biological investigations.

The Chairman submitted for consideration certain proposals of Drs. Hjort (Norway) and Petersen (Denmark), together with some suggestions of Dr. Knipowitsch (Russia).

After a preliminary discussion of various points before the general meeting it was resolved to entrust to a committee the task of drawing up a new biological programme, in which a distinction should be drawn between investigations obligatory upon all the states concerned (*i.e.* a minimum programme), and such investigations as were desirable, but not compulsory, for the participating states. In general, the proposals of Drs. Hjort and Petersen were to be taken as establishing the minimum programme. The questions of plankton and the bottom fauna were reserved for subsequent consideration.

Prof. Pettersson and Dr. Trybom (Sweden) drew attention to the fact that all the countries concerned would probably not be equally prepared for the collection of statistical data over their entire extent; and that for such countries the measurement of the fishes caught during the scientific expeditions should suffice.

Mr. Garstang (Great Britain) drew attention to a paragraph in the German proposals which dealt with investigations concerning the capture of undersized fish. These had a special interest for England, and the British Government attached much importance to them.

Some further discussion took place concerning the German proposals as to the subdivision of territory for biological exploration among the different states.

Mr. Garstang proposed that the English Channel be included within the area of investigation, as being a channel of great importance for the supply of Atlantic water into the North Sea.

Prof. Nansen (Norway) recalled that it was decided at the Stockholm Conference to allot this territory to France and Belgium, if these countries should desire to take part in the international researches. Now that it was settled that France was not to participate, it was naturally to be desired that England and Belgium together would undertake to carry out the investigations in the Channel.

The general question of the delimitation of areas was then referred to committee for more ample consideration.

The following were elected members of the Biological Committee:— Messrs. D'Arcy Thompson, Garstang, Heincke, Henking, Hjort, Hoek, Knipowitsch, Nordqvist, Pettersson, Trybom, with Dr. Gran as Secretary.

The Conference rose at 1.30 p.m.

Wednesday, May 8th.

11 a.m. Prof. Pettersson (Sweden) in the chair.

Prof. Krümmel (Germany) proposed that the hydrographical programme should be provisionally discussed in full congress. The resolution was accepted, and the successive paragraphs of the Stockholm programme passed under review.

A discussion arose as to the margin of time which might be allowed for the seasonal hydrographic cruises in order to satisfy the conditions as to simultaneity.

Messrs. Hjort (Norway), Knipowitsch (Russia), Drechsel (Denmark), and several others remarked that the operations, especially in northern waters and during the winter, would be attended by great difficulties, which might prevent the carrying out of the researches between narrow limits of time.

On the other hand, Mr. Ekman (Sweden) and others were of opinion that the hydrographic conditions changed so quickly in the more restricted areas (*e.g.* Kattegat, Skagerrak, North Sea) that the utmost simultaneity in the observations was desirable.

Upon the proposition of Messrs. Krümmel and Herwig the question was decided in the form given below (A. II., § 2).

Various minor changes were made in the hydrographical programme, and Messrs. Krümmel and Mill were requested to incorporate the amendments in a revised programme to be submitted to the Conference for approval.

The meeting adjourned at 1.30 p.m.

2.30 p.m.

After the Chairman had communicated some telegraphic correspondence with the Belgian delegates, the Conference took up the consideration of the subjects of plankton and the bottom fauna.

A committee consisting of Messrs. Brandt, Cleve, Garstang, Heincke, Hoek, Knipowitsch, and Gran was appointed to draw up a set of proposals on these subjects in connection with the biological programme.

A committee consisting of Messrs. Krümmel, Mill, and Pettersson was appointed to draw up resolutions—(1) as to the desirability of working up the hydrographic material according to the methods of Bjerknes and Sandström (see Resolution J); and (2) as to the desirability of arranging for co-operation with the proposed researches on the temperature of lakes announced by Prof. Forel, of Zurich (see Resolution K). Dr. Herwig assumed that these matters would involve no extra charge on the international budget. As regards the first, the Chairman announced that Sweden was prepared to pay the cost of preliminary researches on the matter; and he supposed that, if these inquiries yielded very important results, the other States, as well as Sweden, would desire to continue the work.

THURSDAY, MAY 9TH.

11 a.m. Prof. Hoek (Holland) in the chair.

The Chairman submitted the printed proposals prepared by the various committees; viz.:—

(1) Additions to the hydrographical programme;
(2) The programme of biological investigations; and
(3) The supplement to the latter in regard to plankton and the fauna and flora of the sea-bed.

The hydrographical programme was accepted without change.

The biological programme was then adopted, paragraph by paragraph, with slight modifications and additions proposed by Messrs. Heincke, Brandt, and D'Arcy Thompson.

Prof. Henking (Germany) proposed that statistical data should be accumulated, with the assistance of fishermen, according to the method followed at Geestemünde.

A committee consisting of Messrs. Garstang, Heincke, Hjort, Hoek, Krümmel, Mill, and Gran was authorised to fix the final form of the programme in accordance with the resolutions adopted by the Conference.

The Chairman read a telegram from the Belgian Government authorising the Belgian Consul to attend the Conference, owing to the illness of the delegates appointed.

The Conference rose at 1 p.m.

FRIDAY, MAY 10TH.

10.30 a.m. Sir Colin Scott Moncrieff (Great Britain) in the chair.

The Belgian Consul, M. Andvord, was present.

The Chairman proposed the despatch of a telegram to the King of Norway.

The Council of Vice-Presidents was authorised to prepare and sign the telegram; to consider the question of the establishment of a Central Bureau; and to consider a proposition of the Chairman's relative to an international understanding with regard to the conditional prohibition of the use of fishing appliances, as for example in the Moray Firth.

Dr. Knipowitsch (Russia) proposed the addition of Mr. Nordqvist to the Council of Vice-Presidents, on the ground that Finland, although to be regarded as part of the Russian Empire, was participating in the explorations in a special manner, and was contributing the necessary funds on its own account. The proposition was accepted.

The Chairman proposed that Dr. Knipowitsch take the chair on the morrow; but the latter declined so that the final meeting might be presided over by Prof. Nansen.

The meeting adjourned at 11 a.m., and met again at

3.30 p.m.

The Chairman read the following telegram addressed to His Majesty:

À sa Majesté le Roi Oscar II., Stockholm.

Réunis à Kristiania pour continuer les travaux préliminaires dont le but est l'étude des Mers du Nord de l'Europe et qui ont été inaugurés si heureusement à Stockholm il y a deux ans,

nous nous souvenons avec une profonde et respectueuse gratitude de l'initiative de votre Majesté et du grand intérêt qu' Elle a daigné témoigner à nos travaux.

L'exemple si élevé donné par votre Majesté, l'amour pour la science, montré à si differentes reprises, nous a encouragé et nous a été d'un très grand appui.

C'est grace à lui que nous comptons arriver avec nos délibérations à des résultats très favorables au developpement du bien-être humain.

(Signed by the President, Vice-Presidents, and General Secretary.)

The Chairman announced that the Council of Vice-Presidents, at a private conference, had been occupied with various propositions concerning the central organisation. They had come to a unanimous agreement in regard to these propositions, which would be forthwith communicated to the Governments concerned, but could not be regarded as matters for discussion.

The Chairman submitted to the Conference a resolution, drawn up by the Council of Vice-Presidents, which was accepted (Resolution G, concerning the Moray Firth).

Mr. Garstang (Great Britain) submitted a resolution concerning the publication of an annual report, which was unanimously accepted (see C, § 4).

Prof. Krümmel (Germany) submitted three resolutions, which were accepted (Resolutions D, H, J).

Dr. Mill (Great Britain) submitted a resolution, which was also adopted (Resolution K).

The Conference rose at 5 o'clock.

Saturday, May 11th.

11.30 a.m. Prof. Nansen (Norway) in the chair.

The following reply from His Majesty the King of Norway was read:—

Congrès hydrographique, Kristiania.

Très reconnaisant pour l'aimable télégramme des Présidents et Vice-présidents, au nom du Congrès, je fais des vœux bien sincères pour le meilleur résultat de ses déliberations dans un but si utile et si intéressant.

Oscar.

M. Gilson, the Belgian delegate, read a programme of the researches which Belgium proposed to undertake as its share in the international explorations. He also proposed that M. Thoulet, Professor at the University of Nancy, should be invited to participate as if a member of the International Conference.

The Conference found it *ultra vires* to accept a proposition of this nature, while regretting that M. Thoulet was not included among the delegates.

The resolutions of the Stockholm Conference with regard to the central organisation were then approved after introduction of certain alterations (see below, Resolution C).

Dr. Herwig (Germany) submitted resolutions concerning the date at which the international explorations should commence, and concerning the first meeting of the International Council, which were accepted (Resolutions E and F).

The work of editing the minutes and arranging the Resolutions for publication was entrusted to a committee consisting of Messrs. Garstang, Heincke, Hjort, Knipowitsch, and Knudsen.

RESOLUTIONS OF THE CONFERENCE, UNANIMOUSLY ADOPTED BY THE UNDERMENTIONED DELEGATES.

Messrs. Brandt, Cleve, Drechsel, Ekman, Garstang, Heincke, Henking, Herwig, Hjort, Hoek, Knipowitsch, Knudsen, Krümmel, Mäckel, Mill, Moncrieff, Nansen, Nordqvist, Petersen, Pettersson, D'Arcy Thompson, Trybom, Wijkander.

Considering that a rational exploitation of the sea should rest as far as possible on scientific inquiry, and considering that international co-operation is the best way of arriving at satisfactory results in this direction, especially if in the execution of the investigations it be kept constantly in view that their primary object is to promote and improve the fisheries through international agreements, this International Conference resolves to recommend to the states concerned the following scheme of investigations which should be carried out for a period of at least five years.

Programme for the Hydrographical and Biological work in the Northern parts of the Atlantic Ocean, the North Sea, the Baltic and adjoining Seas.

A.

THE HYDROGRAPHICAL WORK.

I.

§ 1. The hydrographical researches shall have for their object: the distinction of the different water-strata, according to their geographical distribution, depth, temperature, salinity, gas-contents, plankton, and currents, in order to find the fundamental principles not only for the determination of the external life-conditions of useful marine animals, but also for weather forecasts for extended periods in the interest of agriculture.

II.

§ 2. As the hydrographical conditions are subject to seasonal changes, and as these strongly influence the distribution and life-conditions of useful marine animals, as well as the state of the weather and other general meteorological conditions, it is desirable that the observations should be made so far as possible simultaneously at definite points along the same determined lines in the four typical seasons, so that the middle of the period of working shall be in the first half of February, May, August, and November respectively. The Central Council shall decide how much variation in the date of the seasonal cruises is permissible, having regard to the natural conditions of the different regions in which researches are to be carried out.

III.

The observations referred to in II. would consist of:—

§ 3. Observations of temperature, humidity, and pressure of the air every two hours. Assmann's aspiration thermometer should be used, and self-registering instruments (thermometer and barometer) for interpolation.

Opportunities on board the ships should be afforded to the meteorological offices to make physical observations on the higher levels of the atmosphere by means of kites.

The other meteorological observations are to be carried out according to the methods adopted by the meteorological offices of the nations represented.

The observations, meteorological as well as hydrographical, made on board the special steamers at the time of the survey in the typical months, are to be immediately worked out under the supervision of the Central Bureau (see C) for publication in a Bulletin, wherein the conditions of the sea and the atmosphere are to be represented by tables and synoptic charts in co-operation with the meteorological institutes of the nations represented.

§ 4. The temperature of the surface water shall be taken every two hours or, when necessary, more frequently. It is desirable that self-registering apparatus should be used for interpolation.

Observations on the vertical distribution of temperature are to be taken at the points mentioned in II., and should be taken regularly at intervals of 0, 5, 10, 15, 20, 30, 40, 50, 75, 100, 150, 200, 250, 300, 400 metres, and so on; but all critical parts of the curve must be determined by extra readings.

The bottom temperature is to be investigated with all possible care.

§ 5. At every point and from every depth where the temperature is observed, a sample of water shall be collected for the determination of its salinity and density.

By *salinity* is to be understood the total weight in grammes of the solid matter dissolved in 1,000 grammes of water.

By *density* is to be understood the weight in grammes of 1 cubic centimetre of water of the temperature *in situ* t°, *i.e.* the specific gravity *in situ* referred to pure water of + 4° C. $\left(= S\frac{t^{\circ}}{4^{\circ}}\right)$.

§ 6. Preliminary determinations of the salinity may be made on board ship with appropriate instruments, but the exact determinations of the salinity and density of water samples shall take place in a scientific laboratory on shore. The ratios between Salinity, Density, and Chlorine, given in Dr. Martin Knudsen's Hydrographic Tables, are to be adopted, and the salinity is to be calculated by the use of these Tables from the determinations of chlorine, or from the specific gravity.

§ 7. At certain depths at the points mentioned in II. and elsewhere on the surface, water samples should be collected for analysis of the gas-contents (oxygen, nitrogen, and carbonic acid).

IV.

§ 8. For measurement of depth the *unit* to be adopted is the metre, together with which the depth may be also recorded in English fathoms.

Geographical points are to be referred to the meridian of Greenwich, and horizontal distances are to be expressed in sea miles (= 1,852 metres).

§ 9. Thermometers to be used for the determination of the surface temperature may be either centigrade or Fahrenheit, but for publication all numbers are to be reduced to centigrade.

In the centigrade thermometers for observation of surface temperatures, the distance between two degree marks should be at least 5 mm., and the degree be divided into at least two parts, the Fahrenheit thermometer to be divided in a corresponding manner.

The use of an insulated water-bottle on Pettersson's principle is recommended for moderate depths, and the thermometers used for this apparatus should have a space of at least 10 mm. between the marks of one degree, and the degree should be divided into 10 parts.

For greater depths of the ocean, reversing or other similar thermometers should be used.

The glass to be used for the thermometers should be tested and approved, and the thermometers periodically verified by the Central Bureau (see C. III. § 12).

§ 10. For the determination of salinity and density, either chemical or physical methods may be adopted, provided that the salinity can be determined with an accuracy of 0,05 in a thousand parts (and the density up to 0,00004).

The determination of these constants can be founded either upon chemical analysis of the halogen by weighing or titration, or upon physical determination of the specific gravity by means of the hydrostatic balance, pycnometer, and hydrometer, provided that measures be taken to exclude disturbances arising from thermal effects, capillarity, viscosity, etc.

The same standard sea-water * shall be employed in all cases for standardising the solutions used for chlorine determinations.

The chemical analysis shall be controlled by physical methods, and the physical determinations by chemical analysis in the following manner: From every collection of samples examined at least three shall be selected and sent to the Central Bureau. *Standard samples* shall be sent in return.

V.

§ 11. Samples for gas analysis are to be collected in duplicate in sterilised vacuum tubes.

It is desirable that the existing tables of absorption of nitrogen and oxygen shall be revised.

VI.

§ 12. Qualitative plankton samples should be taken as frequently as possible from the surface by approximate methods simultaneously with the water samples, and also from deeper layers at the stations referred to in § 2 (see below, B. VI., § 12).

§ 13. Observations of the transparency and colour of the water should, when possible, be made at the same points.

VII.

§ 14. Observations on currents and tides should be carried out as frequently as the circumstances allow.

The currents should be examined, when possible, by direct current-meters, and by surface and intermediate floats, and by bottom-rollers.

The ship should be anchored occasionally in order to make frequent observations during a complete period of tide.

VIII.

§ 15. It is desirable that a chart should be prepared, showing the nature of the deposits on the sea-bottom.

The description of the deposits is to be carried out on a definite plan, to be afterwards settled by the Central Bureau.

IX.

§ 16. The normal observations are to be carried out along the lines provisionally drawn on the annexed chart, where *R* denotes the Russian, *F* the Finnish, *S* the Swedish, *G* the German, *Da* the Danish, *Du* the Dutch, *N* the Norwegian, and *B* the British lines; but the Central

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* By *standard* water shall be understood samples of filtered sea-water, the physical and chemical properties of which have been determined with all possible accuracy by analysis, and statements of which are sent to the different laboratories, together with samples.

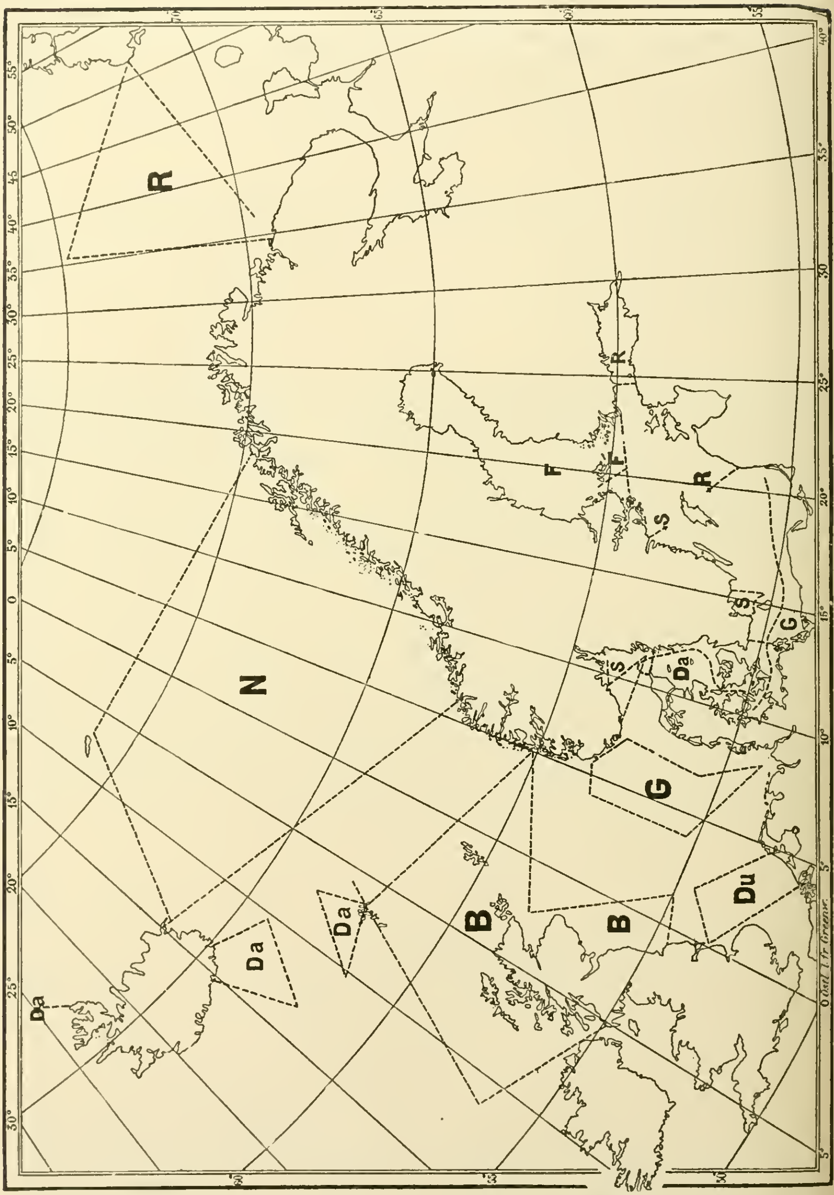

CHART SHOWING THE LINES OF OBSERVATION RECOMMENDED BY THE STOCKHOLM CONFERENCE, ADOPTED WITH SLIGHT MODIFICATIONS BY THE CHRISTIANIA CONFERENCE.

Council shall have authority to make any necessary alterations in these lines, or in the regions where each nation is to work.

The special points are to be decided by the respective nations, and when once chosen the subsequent observations are to be repeated at the same points.

The special instructions for the work will also be given by the respective nations, and the communications as to the extent and the nature of the observations shall take place through the Central Bureau (see C).

X.

§ 17. It is desirable to supplement these investigations by making use of regular liners, light-ships, etc., and coast-stations for the purpose of taking temperature observations and collecting samples of sea-water and plankton. These observations are to be taken not only in the typical months, but also during the intervening periods.

B.

THE BIOLOGICAL WORK.

In each section of the programme which follows, note that—

Roman type indicates those investigations which all the participating countries undertake to carry out simultaneously.

Italics indicate those parts of the complete programme, the carrying out of which is desirable, but optional.

DELIMITATION OF AREAS.

I.

§ 1. It is recommended that each of the nations taking part in the international investigation should undertake the biological study of a definite area to be decided on as in the case of the hydrographical work and to correspond with the divisions adopted for that purpose.

The following is suggested as a preliminary division:—

A. NORTH SEA SOUTH OF 54° N.

1. From 2° E. eastward to Borkum Reef: Holland and Belgium.

2. From Borkum Reef to the Elbe: Germany.

3. From 2° E. westward to the British coast, including the English Channel: Great Britain and Belgium.

B. NORTH SEA, FROM 54° N. TO 58° N.

1. From 2° E. eastward to Jutland and the Naze: Germany and Denmark.

2. From 2° E. westward: Great Britain.

C. NORTH SEA, NORTH OF 58° N., AND NORTH ATLANTIC TO ABOUT 62° N. (the Faröes): Great Britain, Norway, and Denmark.

D. Atlantic Ocean and Arctic Sea north of 62° N.: Norway and Russia.

E. Skagerrak and Kattegat: Norway, Sweden, and Denmark.

F. Western Baltic: Germany, Sweden, and Denmark.

G. Eastern Baltic.

1. Southern part, extending to Bornholm and the Gothland bank on the north and to Memel on the east: Germany.

2. Northern part, including the Gulfs of Finland and Bothnia: Sweden, Russia, and Finland.

It is impossible, as well as undesirable, to draw a hard and fast line between the areas allocated to the various states, and of course the suggested boundaries are not intended to hinder any nation from extending its researches beyond the special areas agreed upon.

Biology of Food-Fishes.

II.

§ 2. Preparation of charts showing the distribution of plaice, sole, turbot, cod, haddock, and herring in the North and Arctic Seas, and of flounder, cod, sprat, and herring in the Baltic, in their different stages of growth, from the earliest stage which is passed upon the bottom up to the full-grown condition.

The investigations to this end are to be carried out as often as possible and, as far as possible, with uniform apparatus, *e.g.* with trawls of different size and mesh, drift-nets, hooks, etc. Measurements of all the fishes caught on each occasion are to be made in such a way as to yield a graphic representation of the relative number of the fishes at every stage of growth. The fullest possible data are to be given concerning sex, degree of maturity, and contents of stomach.

Each fishing operation is to be treated as a scientific experiment, and all the conditions of the experiment are to be carefully recorded (viz. place, depth, nature of bottom, state of water, wind and weather, rate and duration of haul, kind and size of net, etc.). The scheme submitted by Dr. C. G. Joh. Petersen to the Conference may be cited as an example of the journal record of a catch treated in this way.

§ 3. *Efforts should be made to secure a methodic investigation of all marine food-fishes as well as of the most important of those species which make regular migrations from fresh water to the sea, from the egg up to the full-grown condition, and with reference to development, growth, nutrition, reproduction, fecundity, distribution, migrations, and local varieties, and with constant reference to the hydrographic conditions of life.*

As the most important means of carrying out these investigations, fishing experiments of different kinds are to be undertaken in order to elucidate the distribution of food-fishes in the various parts of the sea. In this connection attention should be especially directed to the determination of the depths (whether on the bottom or in the intermediate layers of water) at which particular species of food-fishes can be caught.

It is much to be desired that labelled (or marked) fishes of important species (e.g. plaice, salmon, etc.) should be liberated in as large numbers as possible and over wide areas.

Special researches should also be directed to determine the extent to which important food-fishes are destroyed by their natural enemies.

§ 4. *In connection with the fishing experiments it is desirable that investigations should be made to determine the extent to which the vitality of the fishes caught with the trawl and other fishing implements is affected thereby, and whether such fishes are, or are not, in a condition to live after liberation.*

III.

§ 5. Determination of the quantitative distribution of the eggs, pelagic larvæ, and young fishes of the species mentioned in II. § 2, during the periodic cruises proposed in the hydrographic programme and at the stations fixed for those cruises.

The investigations are to be carried out, firstly, by vertical hauls with Hensen's large egg-net, and secondly, with larger horizontal nets adapted thereto.

§ 6. *It is further desired that the eggs and larvæ of the above-mentioned food-fishes should also be collected and accurately studied in the intervals between the hydrographic cruises, and especially during the spawning periods of these fishes.*

§ 7. *Experiments are further desired upon the artificial fertilisation and hatching of the eggs of the most important of the food-fishes mentioned, not only on the steamers for scientific work, but also on board commercial fishing-vessels and on shore.*

IV.

§ 8. Investigations upon the local varieties of plaice, herring, and mackerel in the entire international area of research are to be assisted by the collection of suitable material in all countries, to be placed at the disposal of individual specialists for detailed investigation, through the agency of the Central Bureau.

§ 9. *It is desirable that such investigations should be extended also to other useful species of animals.*

V.

§ 10. With reference to the question of the extent of the destruction of immature (undersized) fish in the ordinary practice of sea fishing, it shall be a primary object of the fishing experiments to delimit those parts of the sea in which young food-fishes, especially plaice and haddock, occur in great abundance, and to subject these regions to exact biological investigation.

Attempts shall also be made in the larger fishing ports of the North Sea to determine the relative number of such young food-fishes below the average size of maturity (especially plaice and haddock). which are landed by the different methods of fishing, and at different times of the year.

§ 11. *It is desirable to determine the amount of the catches of immature (undersized) food-fishes, especially of plaice and haddock. To this end the official statistical records in the fishing ports should be utilised in the first place, and in the second place the fishing experiments and the analysis of their catches as specified under II.* § 2, *and V.* § 10. *Still richer material will be obtained, if favourable opportunities also occur for sending competent experts on board fishing vessels, in order to determine exactly the quantity and size of the immature (undersized) fishes on the fishing grounds themselves, and to record the same for each catch according to a uniform scheme to be determined.*

PLANKTON AND BOTTOM FAUNA.

VI.

§ 12. Qualitative plankton samples are to be taken as often as possible during the hydrographic seasonal cruises, and not merely from the surface, but also by vertical hauls.

§ 13. *It is desirable that qualitative plankton samples should also be regularly taken in large quantity on other cruises and at definite coast stations, in order to provide plentiful material for more detailed study of the plankton from systematic biological and chemical points of view. The use of closing nets and water-bottles, as well as the filtration of the smallest organisms, is recommended.*

VII.

§ 14. If circumstances permit, quantitative hauls shall be taken with Hensen's plankton-net at the chief hydrographic stations, and be placed through the agency of the Central Bureau at the disposal of those investigators who are prepared to undertake a thorough quantitative investigation.

§ 15. *Control experiments to check the accuracy of the quantitative methods are desirable, as well as quantitative hauls for chemical analysis.*

VIII.

§ 16. Endeavours shall be made with suitable apparatus to investigate more exactly the organisms which inhabit the lowest water layers immediately above the bottom.

§ 17. *Quantitative investigations of this material are also to be desired.*

IX.

§ 18. Systematic investigations upon the macroscopic animal and plant life of the bottom, with special reference to the nutrition of food-fishes.

§ 19. *More detailed investigations are desirable upon the bottom fauna and flora in general, as well as with reference to their dependence on the physical and chemical conditions of the ground.*

Efforts should be made to determine the general topography of the bottom fauna, in order to bring the main faunistic regions into relation with our knowledge of hydrographical conditions, and the distribution of marine food-fishes.

Opportunities should also be given to bacteriologists to carry out investigations upon the bacteria of the sea-bottom, as well as of the overlying water, and to make determinations of the inorganic nitrogenous compounds present in the water.

FISHERY STATISTICS.

X.

§ 20. Elaboration of uniform critical statistics of the sea-fisheries of the participating states, especially giving particulars of the food-fishes landed from those parts of the sea which lie within the international area (especially from the Norwegian and North Sea), according to species, place of capture, time of capture, number and weight.

Particular care is to be given to the preparation of exact statistics of the herring fishery, according to place, time of year, degree of maturity, and dependence on special hydrographic conditions.

Material shall be collected for the preparation of fishery charts, on which the different fishing grounds, and the fisheries conducted thereon, shall be inserted.

§ 21. *In connection with the fishery statistics it is also desirable to determine as precisely as possible the fishing grounds from which the individual catches have been derived. Above all, in the ground-net fisheries* *should the attempt be made, with the assistance of reliable owners and captains of a large number of fishing vessels belonging to important ports, to obtain exact details concerning their catches, as regards place of capture, duration of fishing, species and amount (both number and weight), and to record these details in uniform schedules to be agreed upon.*

C.

ORGANISATION OF AN INTERNATIONAL COUNCIL, A CENTRAL BUREAU, AND AN INTERNATIONAL LABORATORY.

The Conference recommends for the international hydrographic and biological investigation of the seas the establishment of an International Council with a permanent Central Bureau and an International Laboratory.

I.

§ 1. The permanent International Council shall consist of commissioners elected by the Governments interested. Each Government should appoint two commissioners who may be represented at meetings by substitutes, and may be accompanied by experts who, however, shall not be competent to vote.

§ 2. The Council elects its President and Vice-President, and appoints all officials of the Central Bureau. Should the General Secretary represent hydrographical science, one of his principal assistants should be a biologist, and *vice versâ*. The other assistant shall preferably be experienced in statistical work.

§ 3. The Council shall draw up its own order of proceedings.

§ 4. The Conference recommends that the Central Council shall issue, in addition to the ordinary periodical Bulletins, an Annual Report which shall include—

(1) A summary of the work done in each year by the participating countries in carrying out the international programme; (2) an announcement of those discoveries which are of direct practical importance for the fishing industry; and (3) a statement of such recommendations for international action as in the unanimous opinion of the Central Council follow clearly from the international investigations.

§ 5. It will be for the Governments concerned to decide among themselves the amount of the contributions to the central organisation.

The expenses of the central organisation are approximately estimated at £4,800 (96,000 mark) yearly.

Estimate of the Expenditure of the Central Organisation.

		£
1.	General Secretary	750
2.	Two principal Assistants	750
3.	President, for incidental expenses other than travelling expenses	200
4.	Vice-President, for incidental expenses other than travelling expenses	100
5.	Office, scientific and technical assistants, draughtsmen, clerks, servants, postage, telegrams, and similar expenses	1,350
6.	International laboratory	650 *
7.	Travelling expenses Note: Travelling expenses of commissioners attending meetings of the Council shall be borne by their respective Governments.	300
8.	Printing	500
9.	Incidental expenses	200
		£4,800 *

II.

The purpose of the Central Bureau will be—

§ 6. To give uniform directions for the hydrographic and biological researches in accordance with the resolutions drawn up in the programme of the present Conference, or in accordance with such modifications as may be introduced later with the consent of the states represented.

§ 7. To undertake such particular work as may be entrusted to it by the participating Governments.

§ 8. To publish periodical bulletins which shall contain the actual data obtained in the cruises of all the participating states at the earliest possible date, and also such other papers as may prove useful in co-ordinating the international work.

§ 9. To make proposals for the graphic representations, scales, signs, and colours to be used in the charts for the purpose of obtaining uniformity in the publications, the decision regarding which shall rest with the International Council.

§ 10. In connection with the investigations, to make application to the telegraph administrations for the purpose of obtaining determinations from time to time of the changes in the resistance of the cables which cross the areas in any direction.

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* To this sum is to be added a proposed extra grant from the Norwegian Government.

§ 11. The site of the Central Bureau, to be decided by the Governments concerned, shall at the same time be the residence of the General Secretary.

III.

The purpose of the International Laboratory shall be—

§ 12. To control apparatus and to ensure uniformity of methods.

The various apparatus and instruments now used for oceanic research should be examined, in order to settle which are the most trustworthy. Experiments may also be made to improve the apparatus and instruments, or to construct new and better ones.

§ 13. The water-samples sent by the workers of the participating states are to be analysed and examined at the central laboratory, from which also samples of standard water should be provided.

§ 14. In the central laboratory various important investigations of general interest for oceanic researches may be carried out. The various methods for determining salinity, temperature, gases, plankton, etc., of the sea should be carefully tested, in order that standard methods may be fixed.

§ 15. Facilities should be afforded to the participating states for sending students to the central laboratory to be trained for oceanic researches.

§ 16. The investigators of the participating states, or special expeditions, may, if desired, be supplied from the central laboratory with instruments, apparatus, etc., for oceanic research at cost price.

§ 17. The International Laboratory is subordinate to the Central Council, to which its accounts shall be rendered. Its operations shall be reported to the Central Bureau.

§ 18. The site of the central laboratory shall be decided by the Governments concerned, and should be conveniently situated for oceanic researches.

D.

The Conference considers it absolutely indispensable that each of the countries concerned should provide a steamer specially constructed for scientific fishery researches.

E.

It is very desirable that the first periodical cruise should take place as soon as possible, but be not postponed beyond May, 1902, at latest.

The Central Bureau shall commence operations as soon as possible, but not later than the beginning of 1902.

F.

The Conference recommends that the International Council should meet at Copenhagen as soon as the participating Governments have definitely accepted the programme of the Conference; and if that should not be possible, that each Government should send a delegate (accompanied, if desired, by specialists) with full powers to decide what regulations should be made for the prompt constitution of the Central Bureau.

G.

In distinct areas of the sea, as for instance the Moray Firth, in which any Government has undertaken scientific experiments in the interest of the fisheries, and in which the success of the experiments is being hindered by the operations of trawlers, it is to be desired that measures be adopted for the removal of such hindrances.

H.

The Conference recognises the extreme value of Dr. Martin Knudsen's hydrographic tables, and expresses its cordial thanks to him for his admirable work.

The Conference desires that the Central Bureau should be authorised to pay the balance of the expenses of the investigation not covered by the grants already received from Governments and scientific institutions, either out of the general funds, or from any special grants made for the purpose.

J.

The Conference considers it desirable that the hydrographic material should not only be published by the Central Bureau in tabular form, but also that the results should be worked up in such a form as to elucidate the currents of the different layers of water and their relations to wind and to differences of density as motive agencies, by methods similar to those of Mohn and Bjerknes.

K.

The Conference considers it desirable that the International Association for Limnological Studies should, as far as possible, adopt for the investigation of lakes the methods and times of observation approved by this Conference for the study of the sea; and recommends that the Central Bureau should arrange for the regular exchange of the observations made on lakes and on the sea.

L.

The Conference desires to repeat the declaration of the Stockholm Conference that it is of the greatest importance, both for deep-sea fisheries and for the weather forecasts for long periods, that the Faröe Islands and Iceland should be included in the European telegraph system as soon as possible.

(Signed) NANSEN, *President.*
HJORT, *General Secretary.*

Marine Biological Association of the United Kingdom.

Report of the Council, 1900–1901.

The Council and Officers.

There have been four ordinary and two special meetings of the Council during the year, at which the average attendance has been eight. All the meetings were held in the rooms of the Royal Society, and the Council desires to express to the Society the thanks of the Marine Biological Association for the courtesy extended.

The Plymouth Laboratory.

The Plymouth Laboratory has been maintained in a state of efficiency. The smaller of the two gas-engines, which is used for keeping the continuous circulation of sea-water through the aquarium tanks, has been replaced by a new Crossley engine of the latest pattern, and from experience up to date it is anticipated that this change will result in a considerable saving in the cost of working. The pumps have been repeatedly repaired, and will probably do their work for another year or two, after which considerable expense must be faced for their complete renewal.

The Boats.

A favourable opportunity having presented itself for the sale of the steamboat *Busy Bee*, this vessel was disposed of for the sum of £700. The *Busy Bee* was purchased by the Association in 1895 for £600, and £100 was afterwards laid out in fitting her with a steam-winch and other necessary gear for dredging and trawling. Since the date of her purchase she has been constantly at work, and has done good service in the exploration of the inshore waters in the neighbourhood of Plymouth.

The Council has now bought for £850 a larger vessel, the steamship *Oithona*. The *Oithona* is 69 tons gross register, as against the *Busy Bee's* 23 tons, 84 feet long, with a beam of 16 feet, and her bunker capacity should suffice for a week's consumption. A vessel of this size will make much more extended work possible, and can be used for carrying out investigations over the whole of the English Channel and the southern parts of the North Sea.

In considering the low price at which this steamer was purchased, it must be recognised that within the next two or three years she will probably require a new boiler.

The Council was encouraged to face the additional expenditure which the maintenance of a vessel of this size will involve by the promise of the following donations towards a fund for the working expenses of the first four years, viz. G. P. Bidder, Esq., £200, T. H. Riches, Esq., £100, the Hon. R. Guinness, £20. The thanks of the Association are due to these gentlemen for their timely generosity.

The floating laboratory *Dawn*, kindly placed at the disposal of the Association by Mr. J. W. Woodall, was stationed last summer at Salcombe, and proved very suitable for the work required of her. Mr. Woodall has now further improved the boat by the addition of a well-lighted deck-house, which will be used as a workroom. She will be stationed this season at Exmouth.

During the winter months most of the collecting work at Plymouth was done with the sailing boat *Anton Dohrn*.

The Staff.

In consequence of an arrangement made with the Technical Instruction Committees of the Devon County Council and the Plymouth Borough Council, an additional naturalist for fishery research has just been added to the staff, the gentleman appointed being Dr. H. M. Kyle, of the Gatty Marine Laboratory, St. Andrews. Dr. Kyle will spend a portion of his time in conducting classes at the Plymouth Laboratory for the technical instruction of fishermen and in visiting the different fishing centres in the county for a similar purpose, whilst the remainder will be spent in carrying out fishery investigations.

By an arrangement with the Plymouth Technical School, the biological lecturer at that institution has been granted the free use of a table at the Laboratory on condition that he undertakes a definite research approved by the officers of the Association. This table has been occupied during the year by Mr. Stuart Thomson, who has been engaged in an investigation having an important bearing upon practical fishery questions.

The other members of the staff remain as before, namely the Director (Dr. E. J. Allen), the Naturalist in Charge of Fishery Investigations (Mr. Walter Garstang), and the Director's Assistant (Mr. R. A. Todd).

Notwithstanding the additions mentioned above, it may be pointed out that, especially with the larger steamboat now purchased, the staff of investigators is quite insufficient to get the maximum advantage from the plant provided by the Association. With a negligible addition to the working expenses, the Laboratory is now in a position to provide accommodation and material for several more naturalists working throughout the whole year, but the restricted balance-sheet leaves absolutely no funds for additional salaries.

Occupation of Tables.

In addition to the Officers employed by the Association, the following naturalists have been engaged in research work at the Plymouth Laboratory during the year:—

W. M. Aders, Marburg (Hydrozoa).
E. A. N. Arber, B.A., Cambridge (Marine Algæ).
G. P. Bidder, M.A., Plymouth (Sponges).
L. W. Byrne, London (Fishes).
Miss A. Collins, University College, London (General Zoology).
A. D. Darbishire, Oxford (Crustacea).
Sir Charles Eliot, K.C.M.G., C.B. (Nudibranchiata).
F. W. Gamble, D.Sc., Owens College (Mysidæ).
E. S. Goodrich, M.A., Oxford (Fishes).
T. V. Hodgson, London (Polychætes).
Dr. J. N. Langley, Cambridge (Fishes).
J. W. S. Macfie, Cambridge (General Zoology).
R. S. Punnett, B.A., St. Andrews (Fishes).
S. D. Scott, B.A., Cheltenham (Ascidians).
J. S. Thomson, Plymouth (Fishes).

Eleven students from Oxford, Cambridge, and the Yorkshire College attended Mr. Garstang's vacation class in Marine Biology.

The Library.

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the year:—

Transactions and Proceedings of the Royal Society of London.
Royal Society. *Reports of the Malaria Committee.*
Transactions and Proceedings of the Zoological Society of London.
Zoological Record.
Report of the British Association for the Advancement of Science. (Bradford, 1900.)
Journal of the Royal Microscopical Society.
Quarterly Journal of Microscopical Science. (Presented by Messrs. J. and A. Churchill.)
Report of H.M. Inspectors of Fisheries. (*England and Wales.*)
Salmon and Freshwater Fisheries Act. (Report by C. E. Fryer.)

Tenth Annual Meeting of Representatives of Authorities under the Sea Fisheries Regulation Act, 1888.

Sea Fisheries of the United Kingdom, Statistical Tables, etc., for 1900. (Board of Trade.)

Catalogue of the Radcliffe Library, Oxford.

Irish Fisheries. *Inspectors' Report.*

Proceedings of the Royal Dublin Society.

Proceedings of the Royal Irish Academy.

Annual Report of the Fishery Board for Scotland.

Proceedings of the Scottish Microscopical Society.

Report of the Millport Marine Biological Station.

Lancashire Sea Fisheries Committee. *Superintendent's Report.*

Lancashire Sea Fisheries Laboratory *Report.*

Transactions and Annual Report, Manchester Microscopical Society.

Proceedings and Transactions of the Liverpool Biological Society.

Northumberland Sea Fisheries Committee. *Report on Scientific Investigations.*

Proceedings of the Bristol Naturalists' Society.

Cornwall County Council. *Report of the Lecturer on Fishery Subjects.*

Transactions of the Royal Geological Society of Cornwall.

Rousdon Observatory. Meteorological Observations.

Annual Reports of the Department of Marine and Fisheries, Canada.

Transactions and Proceedings of the Royal Society of Canada.

Bulletin of the Natural History Society of New Brunswick.

University of Toronto. *Studies.*

Annals of the South African Museum.

Cape of Good Hope Department of Agriculture. *Report of the Marine Biologist.*

Cape of Good Hope. *Marine Investigations in South Africa.*

Illustrations of the Zoology of the Royal Indian Marine Survey Ship "Investigator."

Administration Report of the Madras Government Museum.

Bulletin of the Madras Government Museum.

Memoirs of the Bernice Panahi Bishop Museum.

Proceedings of the Linnæan Society of New South Wales.

Australian Museum, Sydney. *Memoir IV.;* Parts 2 and 10.

Records of the Australian Museum.

Proceedings of the Royal Society at Victoria.

Fauna Hawiiensis.

Bulletin du Museum d'Histoire Naturelle, Paris.

Bulletin Scientifique de la France et de la Belgique.

Mémoires de la Société Zoologique de France. Bulletin de la Société Zoologique de France.

Congrès International d'Aquiculture et de Pêche. (Paris, 1900.)

Congrès International de Pêches Maritimes et Fluviatiles. (Bayonne—Biarritz, 1899.)

Mémoires présentés au Congrès International des Pêches Maritimes. (Dieppe, 1898.)

Bulletin de la Société Centrale d'Aquiculture et de Pêche.

La Feuille des Jeunes Naturalistes.

Le Mois Scientifique.

Wissenschaftliche Meeresuntersuchungen. Aus der Biologischen Anstalt auf Helgoland.

Mittheilungen des Deutschen Seefischerei-Vereins.

Allgemeine Fischerei-Zeitung.

Mittheilungen aus dem Naturhistorischen Museum in Hamburg.

Bulletin de la Société Impériale des Naturalistes de Moscou.

Laboratoire Ichthyologique de Nikolsk. St. Pétersbourg.

Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg.

Bulletin du Laboratoire Biologique de St. Pétersbourg.

Russian Fishery Journal.

Revue Internationale de Pêche et de Pisciculture.

Bergens Museums. *Aarbog.*

Bergens Museums. *Aarsberetning.*

Bergens Museums. *Meeresfauna von Bergen.*

An Account of the Crustacea of Norway. By G. O. Sars. (Bergens Museum.)

Norsk Fiskeritidende.

Svensk Fiskeri Tidskrift.

Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger.

Jaarsverslag omtrent den Toestand der Visscherijen op de Schelde en Zeeuwsche stroomen.

Trondhjems Biologiske Station. Meddeleser fra stationsanlaeggets Arbeidskomite.

Bihang till Kongl. Svenska Vetenskaps Akademiens Handlingar.

Briefe von Johannes Müller an Anders Retzius.

Selskabet for de Norske Fiskeriers Fremme.

Mittheilungen aus der Zoologischen Station zu Neapel.

La Nuova Notarisia.

The Danish Ingolf Expeditions. Zoological Museum, Copenhagen.

Report of the Danish Biological Station to the Board of Agriculture. Dr. C. G. J. Petersen.

Beretning fra Kommissionen for Videnskabelig Undersögelse af de danske Fravande.

Verslag van den Staat der Nederlandsche Zee Visscherijen.

Mededeelingen over Visscherij.

Tijdschrift der Nederlandsche Dierkundige Vereeniging.

Het Zoölogisch Station der Nederlandsche Dierkundige Vereeniging. Dr. P. P. C. Hoek.

La Cellule.

Bulletin de la Société Belge de Géologie.

Annales du Musée du Congo.

Publication de l'État Independent du Congo, 1901. Les Poissons du Bassin du Congo. G. A. Boulenger.

Revista de Pesca Maritima.

Annaes des Sciencias Naturaes.

Bolletino della Societá di Naturalisti in Napoli.

Bulletin and Report of the United States Commission of Fish and Fisheries.

Bulletin and Memoirs of the Museum of Comparative Zoology at Harvard College

Bulletin of the United States National Museum.

Bulletin and Annual Report of the American Museum of Natural History.

Annals of the New York Academy of Sciences.

Bulletin of the Illinois State Laboratory.

Publications of the Field Columbian Museum.

Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University.

Johns Hopkins University Circulars.

Proceedings of the Boston Society of Natural History.

Proceedings of the American Philosophical Society.

Transactions of the American Microscopical Society.
Studies from the Zoological Laboratory. University of Nebraska.
Proceedings of the Natural History Association of Mirimichi.
Tufts College Studies.
Comunicaciones del Museo Nacional de Buenos Aires.
Anales del Museo Nacional de Montevideo.
Revista Chilena de Historia Natural.
Journal of the College of Science. University of Tokyo.
Journal of the Fisheries Society of Japan.
Journal of the Fisheries Bureau. Tokyo, Japan.
Annotationes Zoologicae Japonenses.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library :—

Photogenic Bacteria. J. E. Barnard.
Selachian Development. Dr. H. Brauss. (Presented by Mr. R. C. Punnett.)
The Maturation and Fertilization of the Egg of Limax agrestis, Linn. Miss E. F. Byrnes.
The Oyster Reefs of North Carolina. C. Cave.
Plankton from the Red Sea. P. T. Cleve.
Plankton from the South Atlantic and the Southern Indian Ocean. Notes on some Atlantic Plankton organisms. P. T. Cleve.
Report on the Plankton collected by the Swedish Expedition to Greenland in 1899. P. T. Cleve.
Freshwater Fishes and Batrachia of the Peninsular of Gaspe P. Q. and their distribution in the Maritime Province of Canada. P. Cox.
The Circulation of the Waters of the North Atlantic Ocean. H. N. Dickson.
Liste sommarie des Flores et Notes Floristiques. (Region de Paris et Champenoise.) A. Dollfus.
La Photographie des Animaux Aquatiques. M. Fabre Domergue.
Rapport présenté au Ministre de la Marine relative à la mission de la "Vienne" sur les fonds de Pêches. M. Fabre Domergue.
Étude sur le rôle et les procédés de la Pisciculture Marine. M. Fabre Domergue.
Die Isolirten Blastomeren des Echinidenkeimes. Dr. H. Driesch.
Studien über das Regulationsvermögen der Organismen. Dr. H. Driesch.
Jamaican Actiniaria. Part 2. *Stickodactylinæ and Zoantheæ.* J. E. Duerden.
The Marine Resources of the British West Indies. J. E. Duerden.
On variation of the rostrum of Palæmonetes vulgaris, Herbst. Dr. G. Duncker.
The Anatomy and Classification of the Arenicolidæ, with some observations on their Post-larval stages. F. W. Gamble and J. H. Ashworth.
Hippolyte varians: a study in colour change. F. W. Keeble and F. W. Gamble.
The Atoll of Minikoi. J. S. Gardiner.
The Natives of the Maldives. J. S. Gardiner.
On the Turbinolid and Oculinoid Corals collected by the Author in the South Pacific. J. S. Gardiner.
On the Astræid Corals collected by the Author in the South Pacific. J. S. Gardiner.
Explorations de la mer sur les Côtes de la Belgique. 1899. G. Gilson.
Note on the name Balanoglossus. S. F. Harmer.

On the occurrence of the "Well Shrimp" Niphargus near Norwich. S. F. Harmer.
On the Structure and Classification of the Cheilostomatous Polyzoa. S. F. Harmer.
A revision of the genus Steganoporella. S. F. Harmer.
The Alcyonaria and Hydrocorallinæ of the Cape of Good Hope. S. J. Hickson.
Report of Crustacea Schizopoda of Ireland. E. W. L. Holt and W. I. Beaumont.
Morphology of the Central Cylinder in the Angiosperms. E. C. Jeffrey.
The Plankton of Echo River Mammoth Cave. C. A. Kofoid.
Molluscous Animals of Scotland. W. Macgillivray.
On Spongioporphyrin, the pigment of Suberites Wilsoni. C. A. MacMunn.
Notes on Polychætes. Miss M. Newbigin.
Museum Normanianum. VI. Supplement to Catalogue of 1890. A. M. Norman.
American Hydroids. The Plumularidæ. C. C. Nutting.
The Fisherman's Nautical Almanack for 1901. O. T. Olsen.
Experiments in Regeneration and in grafting of Hydrozoa. Miss Florence Peebles.
Anatomy of Neohelia porcellana. Miss E. M. Pratt.
On some South Pacific Nemertines collected by Dr. Willey. R. C. Punnett.
Sprot in de Haven van Nieuwediep en de Heincke'sche Methode. H. C. Redeke.
Rhynchodemus Howesi. Dr. R. F. Scharff.
Report on the Sarawak Museum. R. Shelford.
A Description of the Entozoa collected by Dr. A. Willey in the Western Pacific. A. E. Shipley.
The Sea Fisheries of Malabar and South Canara. E. Thurston.
Upon the development of the Enamel in certain Osseous Fishes. C. S. Tomes.
Zur Morphologie der Antennen- und Schalendrüse der Crustaceen. F. Vejdovsky.
Certain laws of variation. The reaction of developing organisms to environment. H. M. Vernon.
Cross fertilisation among Echinoids. H. M. Vernon.
The Commoner Foraminifera of the English Channel, from the Hand Deeps to Start Point, at or near the 30-fathom line. R. H. Worth.

General Report.

An account of Mr. Garstang's examination of the experimental and statistical evidence bearing upon the alleged depletion of the Trawling Grounds has been published in the Journal of the Association, in an essay entitled "The Impoverishment of the Sea." This essay has attracted considerable attention, both from scientific experts and from those who take only a practical interest in fishery matters. Mr. Garstang was called upon to give evidence, based upon the results at which he had arrived, before the Select Committee of the House of Commons on the Sea Fisheries Bill, 1900, and before a departmental committee of the Board of Trade, which was making an inquiry into the best methods of collecting fishery statistics.

Mr. Garstang has also published a report upon the remarkable plague of octopus which occurred in the English Channel during the summers of 1899 and 1900, and proved most destructive to the crab and lobster fisheries.

With a view to the arrangement of international co-operation in scientific investigations dealing with sea fisheries, a second Conference recently met at Christiania upon the invitation of the Norwegian Government, and was presided over by Professor Nansen. At this Conference the Association was represented by Mr. Garstang, who was appointed one of the delegates of the British Government. The Conference has drawn up a detailed scheme for the hydrographical and biological investigation of the northern parts of the Atlantic Ocean, the North Sea, and the adjoining seas. The Council cf the Association is taking steps to urge upon His Majesty's Government the great importance which it attaches to the successful carrying out of the programme of the Conference, and the desirability of Great Britain taking its full and proper share in the conduct of the work.

Since the commencement of the current year (1901), Mr. Stuart Thompson has been engaged in a research on the periodic growth of fish scales as an index of age. He has directed his attention more especially to the families Gadidæ and Pleuronectidæ, and has been successful in demonstrating that the periodic additions to the size of the scales during growth vary in extent according to the season of the year. The scales thus present a series of annual rings, which can be used to determine the age of the fish with great precision. The results of this inquiry will doubtless be of much value in various branches of fishery investigation.

The examination of the fish population in the estuarine waters of the Hamoaze, which has now been carried on for several years, has been continued regularly.

During the summer of 1900 a detailed investigation was made of the fauna of Salcombe Harbour. For the purposes of this work the laboratory-boat *Dawn*, which had been lent to the Association by Mr. J. W. Woodall, was stationed at Salcombe, and the different shores and channels of the harbour were carefully examined. The results of the investigation were published in the Journal of the Association issued in November.

The systematic examination of the fauna on the grounds in the immediate neighbourhood of Plymouth has been continued, and a large number of records of the local distribution of the various species living in the district have now been brought together in a form convenient for reference. These records furnish the basis for a detailed history of the distribution of the marine fauna of Plymouth.

The Association continues to send out to the Universities, Colleges, and Museums living and preserved specimens of marine animals and plants, and during the present year a large part of the necessary apparatus for dredging and trawling work required by several expeditions, including the National Antarctic Expedition, has been constructed at the Laboratory under the superintendence of the staff.

It may be mentioned that a growing feature of the work done at the Laboratory is the correspondence with other institutions in various parts of the world, whereby an exchange of experience on definite problems is made, augmenting considerably the efficiency of any one institution.

Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association :—

DARBISHIRE, A.D.—*On the habits of* PINNOTHERES PISUM. Reports Brit. Assoc., Bradford, 1900, p. 399.

DUNCKER, G.—*Variation und Asymetrie bei* PLEURONECTES FLESUS, L. Wissenschaftliche Meeresuntersuchungen, Bd. II. (Helgoland), p. 333, 1900.

GAMBLE, F. W., and ASHWORTH, J. H.—*The Anatomy and Classification of the Arenicolidæ, with some observations on their post-larval stages.* Quart. Journ. Micr. Sci., vol. xliii. p. 419, 1900.

GOODRICH, E. S.—*On the Nephridia of the Polychæta,* III. Quart. Journ. Micr. Sci., vol. xliii. p. 699, 1900.

SHIPLEY, A. E.—*On some Parasites found in* ECHINUS ESCULENTUS, L. Quart. Journ. Micr. Sci., vol. xliv. p. 281, 1901.

Donations and Receipts.

The receipts for the year include the grants from His Majesty's Treasury (£1,000), and the Worshipful Company of Fishmongers (£400), Special Donations (£67), Composition Fees (£15), Annual Subscriptions (£136), Rent of Tables in the Laboratory (£65), Sale of Specimens (£251), Admission to the Tank Room (£109). The expenses in connection with the up-keep of the laboratory-boat *Dawn* at Salcombe were met by Mr. J. W. Woodall, to whom the thanks of the Association are due.

In view of the fact that repairs to buildings and machinery must at some time be effected at considerable expense, the Council has resolved that the sum of £175 carried over for this purpose from the year 1899–1900 should be denominated the "Plant Repairs and Renewals Fund," and that a sum of not less than £25 shall be assigned annually out of income to this fund, only to be drawn on for exceptional expenditure on the plant or machinery.

Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1901–1902:—

President.

Prof. E. RAY LANKESTER, LL.D., F.R.S.

Vice-Presidents.

The Duke of ABERCORN, K.G., C.B.
The Earl of ST. GERMANS.
The Earl of MORLEY.
The Earl of DUCIE, F.R.S.
Lord AVEBURY, F.R.S.
Lord TWEEDMOUTH.
Lord WALSINGHAM, F.R S.
The Right Hon. A. J. BALFOUR, M.P., F.R.S.
Sir EDWARD BIRKBECK, Bart.
The Right Hon. JOSEPH CHAMBERLAIN, M.P.
Sir MICHAEL FOSTER, M.P., F.R.S.
A. C. L. GÜNTHER, Esq., F.R.S.
Sir JOHN MURRAY, F.R.S.
Prof. ALFRED NEWTON, F.R.S.
Rev. Canon NORMAN, D.C.L., F.R.S.
Sir HENRY THOMPSON, Bart.
Rear-Admiral Sir W. J. L. WHARTON, K.C.B., F.R.S.

Members of Council.

Prof. F. JEFFREY BELL.
G. P. BIDDER, Esq.
G. C. BOURNE, Esq., F.L.S.
FRANCIS DARWIN, Esq., F.R.S.
G. HERBERT FOWLER, Esq.
S. F. HARMER, Esq., F.R.S.
Prof. W. A. HERDMAN, F.R.S.
Prof. G. B. HOWES, F.R.S.
J. J. LISTER, Esq., F.R.S.
Prof. E. A. MINCHIN.
D. H. SCOTT, Esq., F.R.S.
Prof. CHARLES STEWART, F.R.S.
Prof. D'ARCY W. THOMPSON, C.B.
Prof. W. F. R. WELDON, F.R.S.

Hon. Treasurer.

J. A. TRAVERS, Esq.

Hon. Secretary.

E. J. ALLEN, Esq., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council:—

ROBERT BAYLY, Esq.
J. P. THOMASSON, Esq.
THE PRIME WARDEN OF THE FISHMONGERS' COMPANY.
E. L. BECKWITH, Esq. (Fishmongers' Company).
Prof. Sir J. BURDON SANDERSON, Bart., F.R.S. (Oxford University).
A. E. SHIPLEY, Esq. (Cambridge University).
Prof. W. F. R. WELDON, F.R.S. (Brit. Assoc. for Advmt of Science.

Dr. *Statement of Receipts and Expenditure for the Year ending 31st May, 1901.* *Cr.*

	£ s. d.	£ s. d.
To Balance from last year, being Cash at Bank and in hand, now allocated as follows:—		
On General Account	3 15 11	
On Plant, Repairs and Renewals Fund	175 0 0	178 15 11
„ Current Income:—		
H.M. Treasury	1,000 0 0	
Fishmongers' Company (for current year)	400 0 0	
Annual Subscriptions	136 9 0	
Rent of Tables	64 18 6	
Interest on Investment	19 1 9	1,620 9 3
„ Extraordinary Receipts:—		
Life Member's Composition Fee—		
J. W. S. Macfie	15 15 0	
Special Donations	67 9 8	83 4 8
„ Fishmongers' Company (on account of Subscription for year to 31st May, 1902)		200 0 0
		£2,082 9 10

Investment held 31st May, 1901, £500 Forth Bridge Railway 4% Guaranteed Stock.

Examined and found correct,
(Signed) Edwin Waterhouse.
Stephen E. Spring-Rice.
F. Jeffrey Bell.
George P. Bidder.

		£ s. d.	£ s. d.
By Current Expenses:—			
Salaries and Wages—			
Director		200 0 0	
Naturalist		250 0 0	
Director's Assistant		91 13 4	
Wages		522 18 0	1,064 11 4
Travelling Expenses			44 6 9
Library			87 17 5
Journal, Printing and Illustrating		122 8 3	
Less Sales of Journal		24 11 2	97 17 1
Buildings and Public Tank Room—			
Gas, Water, Coal, etc.		122 12 6	
Stocking Tanks, Feeding, etc.		24 12 4	
Maintenance and Renewals		137 8 2	
Rent of Land, Rates, Taxes, and Insurance		15 11 11	
		300 4 11	
Less Admissions to Tank Room		108 16 3	191 8 8
Laboratory, Boats, and Sundry Expenses—			
Stationery, Office Printing, and Postage		110 3 6	
Glass, Chemicals, and Apparatus	£138 13 1		
Less Sales	40 12 11	98 0 2	
Purchase of Specimens		30 5 4	
Maintenance and Renewals of Boats, Nets, and Gear	£419 6 11		
Less Sales	124 8 3	294 18 8	
Coal for Steamer		62 3 4	
Insurance		1 10 0	
Boat Hire		7 1 6	
		604 2 6	
Less Sale of Specimens		251 11 2	352 11 4
			1,838 12 7
By Extraordinary Expenditure—			
Cost and Expenses of Purchase of s.s. *Oithona*		858 8 0	
Less Amount realised by Sale of s.s. *Busy Bee*	£700 0 0		
Less Commission on Sale	17 10 0	682 10 0	175 18 0
By Balance of Cash at Bank and in hand, Plant, Repairs, and Renewals Fund, including £25 added during year		200 0 0	
Less Amount overpaid on General Account		132 0 9	67 19 3
			£2,082 9 10

Director's Report.

The year which has elapsed since the publication of the last number of the Journal has been marked by substantial progress in the work of the Association in one or two directions. In the first place, the small steamer *Busy Bee*, which had for several years done good service in collecting in the immediate neighbourhood of Plymouth, was sold on favourable terms, and a larger vessel, the s.s. *Oithona*, was bought to replace her. The *Oithona* is a much more capable seaboat than the *Busy Bee*, and is provided with excellent accommodation, so that she is able to make more extended cruises, and it is possible for our naturalists to live on board her for longer periods with comparative comfort.

Considerable extra expense is of course involved in running this larger vessel, but we have been materially assisted in this respect by the generosity of gentlemen interested in our work. Towards a fund intended to meet the working expenses of the first four years the following contributions have been received:—G. P. Bidder, Esq., £200; T. H. Riches, Esq., £100; the Hon. R. Guinness, £20; W. F. Thomas, Esq., £5. But even with this additional help we are only able to run the vessel for a portion of the winter months.

Secondly, in conjunction with the Technical Education Committee of the Devon County Council, our fisheries staff has been increased by an additional naturalist, one half of whose time is devoted to fishery research, and the other half to the technical instruction of fishermen. Dr. H. M. Kyle, formerly of Saint Andrews, has been appointed to this post. Mr. F. Balfour Browne has also been appointed an assistant (honorary) to Mr. Garstang for fishery research.

The Laboratory buildings and machinery have been maintained in a state of efficiency. It has been found necessary to replace the gas-engine which is used for circulating the sea-water through the aquarium tanks. The old engine had been in constant use since the opening of the Laboratory, and was not a new one when it became the property of the Association. One of the rotary pumps used for the same purpose has also been practically made new, so that considerable expense has been necessary for the up-keep of machinery.

The general detailed study of the distribution of the marine fauna of the district has been continued by myself and my assistant, Mr. R. A. Todd. In this connection Mr. J. W. Woodall's floating laboratory *Dawn* was stationed during the summer at Exmouth, for the purpose of enabling us to study the fauna of the Exe estuary. Before leaving for Exmouth the vessel had been very much improved by Mr. Woodall by the addition of a deckhouse, which forms an excellent laboratory. A report upon the survey of the Exe estuary is contained in the present number of the Journal. Our thanks are again due to Mr. Woodall for placing the *Dawn* at our disposal and paying the expenses in connection with her up-keep at Exmouth.

The study of the fauna in the immediate neighbourhood of Plymouth has been continued, and as it proceeds detailed records of the work are kept at the Laboratory.

Mr. Garstang has been largely engaged during the year in working out the results of the periodic cruises which he has made at the mouth of the English Channel for the purpose of investigating the physical and biological conditions prevailing at different seasons of the year. This work, however, has been somewhat interfered with by the fact that Mr. Garstang was appointed by the Government to act as one of the British delegates to the International Conference for the Exploration of the Sea, which met at Christiania in May. Matters connected with this Conference have occupied a great deal of time and attention.

Experiments upon the rearing of larval fishes were again undertaken during the breeding season, and a substantial advance was made in the methods employed. These experiments will be continued during the coming season.

In conjunction with the Devon Sea Fisheries Committee, trawling experiments in the bays on the South Devon coast have been renewed. These bays have been closed to trawlers for several years, and the Committee are anxious that a thorough investigation should be made of the distribution of the various species of fish throughout the year, of their spawning grounds, of the distribution of immature fish, and of such other matters as may tend to throw light upon the working of their bye-laws. These investigations are being carried out by Dr. Kyle, and the *Oithona* is used for the trawling work, hauls being made every month at the different stations.

Mr. J. Stuart Thomson has been occupied with an investigation of the periodic growth of the scales of fishes as an indication of age. A preliminary account of the results at which he has arrived is now published (see p. 373).

A word of explanation is necessary with reference to the somewhat long interval since the issue of the last number of the Journal. It was our intention to have published an enlarged number in October containing the detailed results of the plankton investigations at the mouth of the Channel. As there has been an unavoidable delay in the preparation of the report on this subject, it has been held over for the time and the present number issued.

E. J. Allen.

December 18th, 1901.

Marine Biological Association of the United Kingdom.

LIST
OF
Governors, Founders, and Members.

1st DECEMBER, 1901.

I.—Governors.

The British Association for the Advancement of Science, *Burlington House, W.*	£500
The University of Cambridge	£500
The Worshipful Company of Clothworkers, 41, *Mincing Lane, E.C.*	£500
The Worshipful Company of Fishmongers, *London Bridge*	£5905
The University of Oxford	£500
Bayly, Robert (the late)	£1000
Bayly, John (the late)	£600
Thomasson, J. P., *Woodside, near Bolton*	£970

II.—Founders.

* Member of Council. † Vice-President. ‡ President.

1884	The Corporation of the City of London	£210
1884	The Worshipful Company of Mercers, *Mercers' Hall, Cheapside*	£341 5*s.*
1884	The Worshipful Company of Goldsmiths, *Goldsmiths' Hall, E.C.*	£100
1884	The Royal Microscopical Society, 20, *Hanover Square, W.*	£100
1884	The Royal Society, *Burlington House, Piccadilly, W.*	£350
1884	The Zoological Society, 3, *Hanover Square, W.*	£100
1884	Bulteel, Thos., *Radford, Plymouth*	£100
1884	Burdett-Coutts, W. L. A. Bartlett, 1, *Stratton Street, Piccadilly, W.*	£100
1884	Crisp, Frank, LL.B., B.A., Treas. Linn. Soc., 17, *Throgmorton Avenue, E.C.*	£100
1884	Daubeny, Captain Giles A., *Les Colondalles, Montreux, Switzerland*	£100
1884	Eddy, J. Ray, 11, *Wood Lane, Falmouth*	£100
1884	Gassiott, John P., *The Culvers, Carshalton, Surrey*	£100
‡1884	Lankester, Prof. E. Ray, F.R.S., *British Museum (Natural History), South Kensington, S.W.*	£100
1884	Lister, S. Cunliffe, *Swinton Park, Masham, Yorkshire*	£100

*

†1884	The Rt. Hon. Lord Avebury, F.R.S., *High Elms, Bromley, Kent*	£100
1884	Poulton, Prof. Edward B., M.A., F.R.S., *Wykeham House, Oxford*	£100
1884	Romanes, G. J., LL.D., F.R.S. (the late)	£100
1884	Worthington, James (the late)	£100
1885	Derby, the late Earl of	£100
*1887	Weldon, Prof. W. F. R., F.R.S., *Merton Lea, Oxford*	£100
1888	Bury, Henry, M.A., *Trinity College, Cambridge*	£100
1888	The Worshipful Company of Drapers, *Drapers' Hall, E.C.*	£315
1889	The Worshipful Company of Grocers, *Poultry, E.C.*	£120
†1889	Thompson, Sir Henry, Bart., 35, *Wimpole Street, W.*	£110
1889	Revelstoke, The late Lord	£100
1890	Riches, T. H., B.A., *Kitwells, Shenley, Herts*	£130
*1900	Bidder, G. P., 9, *Windsor Terrace, Plymouth*	£300

III.—Members.

ann. signifies that the Member is liable to an Annual Subscription of One Guinea.
Ann. signifies that the subscription for the year 1900-1 has been paid.
C. signifies that he has paid a Composition Fee of Fifteen Guineas in lieu of Annual Subscription.

1897	Adams, W. R., 57, *Wood Vale, Lordship Lane, London, S.E.*	Ann.
1900	Aders, W. M., 28, *St. John's Wood Road, London, N.W.*	Ann.
1884	Alger, W. H., 8, *The Esplanade, Plymouth*	*C.*
*1895	Allen, E. J., D.Sc., *The Laboratory, Plymouth*	Ann.
1893	Ascroft, R. L., 11, *Park Street, Lytham, Lancs*	Ann.
1892	Assheton, R., *Granchester, Cambridge*	£20
1899	Auckland, The Rt. Hon. Lord, *Kitley, Plymouth*	Ann.
1884	Bailey, Charles, F.L.S., *Ashfield, College Road, Whalley Range, Manchester*	Ann.
1893	Bailey, W. E., *Porth Enys Museum, Penzance*	*C.*
1884	Balfour, Prof. Bayley, F.R.S., *Royal Botanic Gardens, Edinburgh*	*C.*
1893	Bassett-Smith, P. W., Staff-Surgeon, R.N., *R.N. Hospital, Haslar, Portsmouth*	Ann.
1884	Bateson, Wm., F.R.S., *St. John's College, Cambridge*	Ann.
1897	Baxter, G. H., *Hutton Road, Brentwood, Essex*	Ann.
1884	Bayliss, W. Maddock, D.Sc., *St. Cuthberts, West Heath Road, Hampstead.*	Ann.
1884	Bayly, Miss, *Seven Trees, Plymouth*	£50
1884	Bayly, Miss Anna, *Seven Trees, Plymouth*	£50
1897	Baynes, R. W., 4, *Saltram Place, Plymouth*	*ann.*
1884	Beaumont, W. I., B.A., *The Laboratory, Plymouth*	Ann.
1885	Beck, Conrad, 68, *Cornhill, E.C.*	*C.*
*1889	Beckwith, E. L., *The Knoll, Eastbourne*	Ann.
1887	Beddard, F. E., F.R.S., *Zoological Society's Gardens, Regent's Park, N.W.*	Ann.
1884	Beddington, Alfred H., 8, *Cornwall Terrace, Regent's Park, N.W.*	*C.*
1897	Bedford, Mrs., 326, *Camden Road, London, N.*	Ann.
*1884	Bell, Prof. F. Jeffrey, 35, *Cambridge Street, Hyde Park, W.*	Ann.
†1885	Birkbeck, Sir Edward, Bart., 10, *Charles Street, Berkeley Square, W.*	Ann.
1893	Bles, A. J. S., *Palm House, Higher Broughton, Manchester*	Ann.
1889	Bolitho, T. B., *Chyandour, Penzance*	Ann.

1884	Bompas, G. C., 121, *Westbourne Terrace, Hyde Park, London, W.*	Ann.
1884	Bossey, Francis, M.D., *Mayfield, Redhill, Surrey*	Ann.
1884	Bostock, E., *Stone, Staffordshire*	Ann.
1890	Bourne, Prof. A. G., F.R.S., *The Presidency College, Madras*	Ann.
*1884	Bourne, Gilbert C., M.A., *Savile House, Mansfield Road, Oxford*	Ann.
1898	Bowles, Col. Henry, M.P., *Forty Hall, Enfield*	Ann.
1895	Bridge, Prof. T. W., D.Sc., *University of Birmingham*	Ann.
1890	Brindley, H. H., M.A., 4, *Derana Terrace, Huntingdon Road, Cambridge*	Ann.
1886	Brooksbank, Mrs. M., *Leigh Place, Godstone, Surrey*	*C.*
1884	Brown, Arthur W. W., 37, *Evelyn Mansions, Carlisle Place, Victoria Street, S.W.*	*C.*
1893	Browne, Edward T., B.A., 141, *Uxbridge Road, W.*	Ann.
1893	Buchanan, Miss Florence, B.Sc., *The Museum, Oxford*	Ann.
1884	Buckton, G. B., *Weycombe, Haslemere*	Ann.
1896	Bulstrode, H. P., M.D., 4, *The Mansions, Earl's Court, S.W.*	Ann.
1887	Burd, J. S. (the late)	Ann.
1889	Burnard, Robert, 3, *Hillsborough, Plymouth*	*ann.*
1897	Byrne, L. W., B.A., 33, *Lancaster Gate, London*	Ann.
1884	Caine, H. T., 5, *Upper Wimpole Street, London, W.*	*C.*
1884	Caine, W. S., M.P., *The Terrace, Clapham Common, S.W.*	£21
1887	Caldwell, W. H.	*C.*
1884	Canterbury, His Grace the Archbishop of, *Lambeth Palace, S.E.*	Ann.
†1884	Chamberlain, Rt. Hon. J., M.P., 40, *Prince's Gardens, S.W.*	Ann.
1884	Christy, Thomas Howard	*C.*
1887	Clarke, Rt. Hon. Sir E., K.C., 5, *Essex Court, Temple, E.C.*	£25
1884	Clay, Dr. R. H., *Windsor Villas, Plymouth*	Ann.
1885	Clerk, Major-General H., F.R.S., "*Mountfield*," 5, *Upper Maze Hill, St. Leonards-on-Sea, Sussex*	£21
1886	Coates and Co., *Southside Street, Plymouth*	*C.*
1885	Collier Bros., *Old Town Street, Plymouth*	*C.*
1900	Cooper, W. F., B.A., *Ashlyns Hall, Berkhamsted*	Ann.
1889	Crossman, Major-General Sir William, K.C.M.G. (the late)	Ann.
*1885	Darwin, Francis, F.R.S., *Wychfield, Cambridge*	*C.*
1885	Darwin, W. E., *Ridgemount, Bassett, Southampton*	£20
1889	Davies, H. R., *Treborth, Bangor*	Ann.
1884	Dewick, Rev. E. S., M.A., F.G.S., 26, *Oxford Square, Hyde Park, W.*	*C.*
1885	Dixey, F. A., M.A. Oxon., *Wadham College, Oxford*	£26 5*s.* *and* Ann.
1890	Driesch, Hans, Ph.D., *Philosophenweg* 5, *Heidelberg, Germany*	*C.*
†1889	Ducie, The Rt. Hon. the Earl of, F.R.S., *Tortworth Court, Falfield, R.S.O.*	£50 15*s.*
1884	Dunning, J. W., 4, *Talbot Square, W.*	£26 5*s.*
1884	Dyer, Sir W. T. Thiselton, M.A., K.C.M.G., F.R.S., *Director of the Royal Gardens, Kew*	*C.*
1893	Edwards, S. Stanley, F.Z.S., *Kidbrook Lodge, Blackheath, S.E.*	*ann.*
1898	Eliot, Sir C. N. E., K.C.M.G., C.B., *British Agency, Zanzibar*	Ann.
1891	Ellis, Hon. Evelyn, *Rosenais, Datchet, Windsor*	*C.*
1893	Enys, John Davies, *Enys, Penryn, Cornwall*	Ann.
1884	Evans, Sir John, D.C.L., F.R.S., *Nash Mills, Hemel Hempstead*	£20
1885	Ewart, Prof. J. Cossar, M.D., *University, Edinburgh*	£25

1894	Ferrier, David, M.A., M.D., F.R.S., 34, *Cavendish Square, W.*	Ann.
1884	Fison, Frederick W., *Greenholme, Burley-in-Wharfedale, Leeds*	*C.*
1897	Foster, Richard, *Windsworth, Looe, R.S.O.*	Ann.
*1885	Fowler, G. Herbert, B.A., Ph.D., 58, *Bedford Gardens, London, W.*	Ann.
1884	Fox, George H., *Wodehouse Place, Falmouth*	Ann.
1886	Freeman, F. F., *Abbotsfield, Tavistock, S. Devon*	*C.*
1884	Fry, George, F.L.S., *Carlin Brae, Berwick-on-Tweed*	£21
1884	Fryer, Charles E., *Board of Trade, S.W.*	Ann.
1898	Ganz, C., *Aldeburgh, Suffolk*	Ann.
1892	Galton, F., F.R.S., 42, *Rutland Gate, S.W.*	Ann.
1885	Gaskell, W. H., F.R.S., *The Uplands, Shelford, Cambridge*	*C.*
1885	Gaskell, E. H.	*C.*
1899	Gardiner, Dr. Edw. G., *Woods Hole, Mass., U.S.A.*	*C.*
1893	Gatty, Charles Henry, LL.D., F.L.S., *Felbridge Place, East Grinstead*	*C.*
1897	Gibbs, Hon. Henry, 10, *Lennox Gardens, S.W.*	Ann.
1884	Gibson, Ernest, F.Z.S., c/o Fraser, Stoddart, and Ballingall, 16, *Castle Street, Edinburgh*	Ann.
1901	Giles, Col. G. M., *Byfield, Mannamead, Plymouth*	*C.*
1885	Gordon, Rev. J. M., *St. John's Vicarage, Redhill, Surrey*	Ann.
1885	Gotch, Prof. F., F.R.S., *University Museum, Oxford*	Ann.
1884	Grove, E., *Norlington, Preston, Brighton*	Ann.
1884	Groves, J. W., *Wargrave Lodge, Wargrave-on-Thames*	Ann.
1900	Groves, C. E., F.R.S., *Guy's Hospital, London, S.E.*	Ann.
1899	Guinness, Hon. Rupert, *Elveden, Thetford*	£35 15*s.*
†1884	Günther, Dr. Albert, F.R.S., 2, *Lichfield Road, Kew Gardens*	Ann.
1900	Gurney, E., 28, *Grosvenor Place, S.W.*	Ann.
1901	Gurney, R., 28, *Grosvenor Place, S.W.*	Ann.
1884	Haddon, Prof. Alfred C., M.A., F.R.S., *Innisfail, Hills Road, Cambridge*	Ann.
1884	Halliburton, Prof. W. D., M.D., F.R.S., *Church Cottage*, 17, *Marylebone Road, London, W.*	Ann.
1884	Hannah, Robert, 82, *Addison Road, Kensington, W.*	*C.*
*1885	Harmer, S. F., D.Sc., F.R.S., *King's College, Cambridge*	*C.*
1889	Harvey, T. H., *Cattedown, Plymouth*	Ann.
1888	Haselwood, J. E., 3, *Lennox Place, Brighton*	*C.*
1884	Haslam, Miss E. Rosa, *Ravenswood, Bolton*	£20
1884	Hayne, The Rt. Hon. C. Seale, M.P., 6, *Upper Belgrave Street, S.W.*	Ann.
1884	Head, J. Merrick, F.R.G.S., J.P., *Ardverness, Reigate*	Ann.
1884	Heape, Walter, *Heyroun, Chaucer Road, Cambridge*	*C.*
*1884	Herdman, Prof. W. A., F.R.S., *University College, Liverpool*	Ann.
1884	Herschel, Col. J., R.E., F.R.S., *Observatory House, Slough, Berks.*	*C.*
1889	Heywood, Mrs. E. S., *Light Oaks, Manchester*	*C.*
1884	Hickson, Prof. Sydney J., M.A., D.Sc., F.R.S., *Ellesmere House, Wilenslow Road, Withington, Manchester*	Ann.
1897	Hodgson, T. V., c/o L. E. Sexton, Esq., 17, *Collings Park, Higher Compton, Plymouth*	Ann.
1884	Holdsworth, E. W. H., F.L.S., F.Z.S., *Lucerne House, Dartmouth*	Ann.
*1887	Howes, Prof. G. Bond, F.R.S., F.L.S., *Science and Art Department, South Kensington*	Ann.
1884	Hudleston, W. H., M.A., F.R.S., 8, *Stanhope Gardens, South Kensington, S.W.*	Ann.

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With Preface by

E. RAY LANKESTER, M.A., LL.D., F.R.S.,

PROFESSOR OF COMPARATIVE ANATOMY IN THE UNIVERSITY OF OXFORD.

OBJECTS

OF THE

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THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence, the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter. the payment of servants and fishermen, the hire and maintenance of fishing boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff. In no case does any one salary exceed £250.

The Association has received some £32,500, of which £16,000 has been granted by the Treasury. The annual revenue which can be at present counted on is about £1,600, of which £1,000 a year is granted by the Treasury, the remainder being principally made up in subscriptions.

The admirable Marine Biological Laboratory at Naples, founded and directed by Dr. Dohrn, has cost about £20,000, including steam launches, &c., whilst it has an annual budget of £7,000.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

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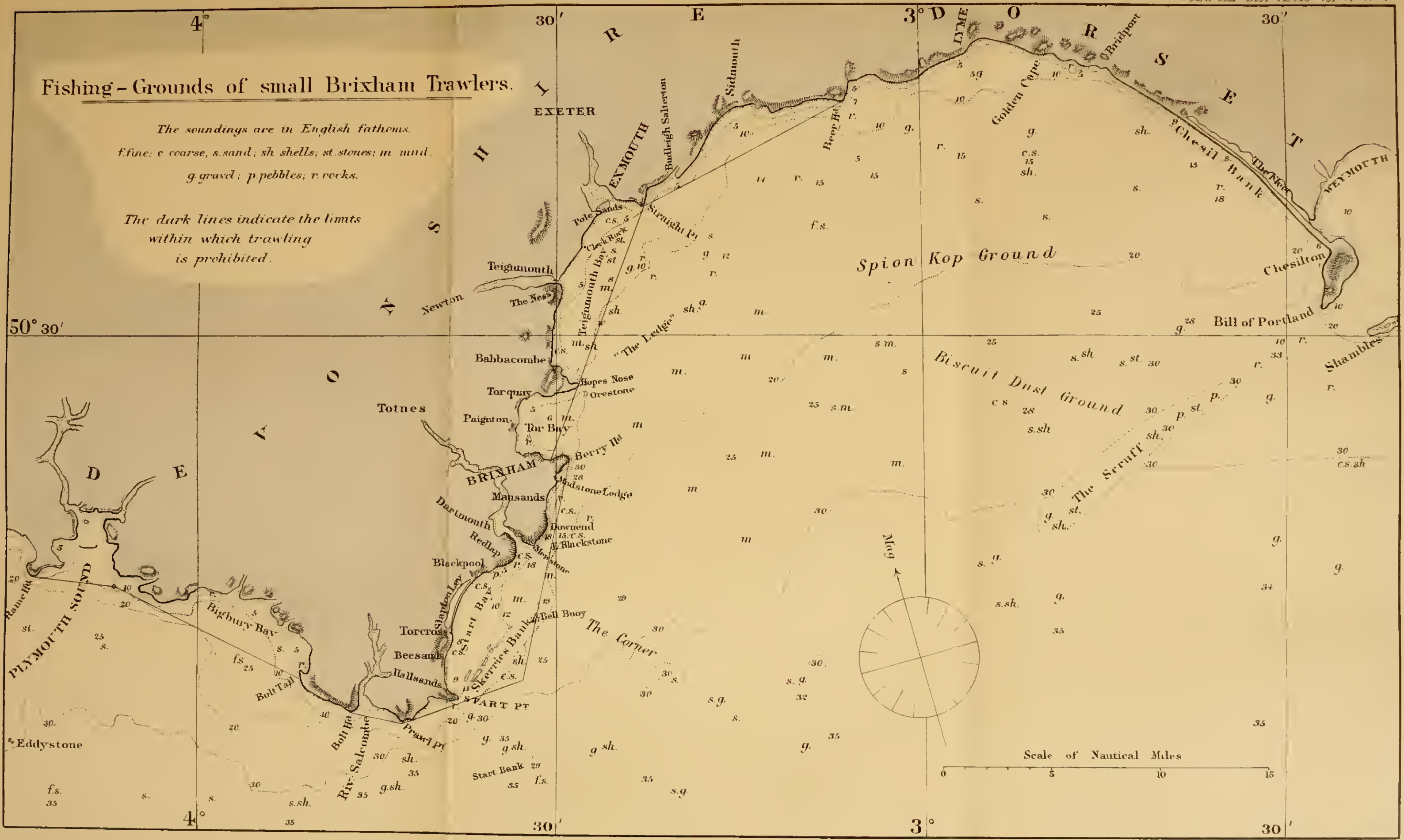

Fishing-Grounds of small Brixham Trawlers.

The soundings are in English fathoms.

f. fine; c. coarse, s. sand; sh. shells; st. stones; m. mud.

g. gravel; p. pebbles; r. rocks.

The dark lines indicate the limits within which trawling is prohibited.

4°
30′
3°
30′
50° 30′
DEVONSHIRE
DORSET
DEVON
EXETER
EXMOUTH
Budleigh Salterton
Sidmouth
Beer Hd
LYME
Golden Cape
Bridport
Chesil Bank
The Fleet
WEYMOUTH
Chesilton
Bill of Portland
Shambles
Pole Sands
Straight Pt
Clerk Rock
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Teignmouth
Newton
The Ness
The Ledge
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Bigbury Bay
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PLYMOUTH SOUND
Eddystone
Start Bank
Spion Kop Ground
Biscuit Dust Ground
The Scruff
The Corner
Mag
Scale of Nautical Miles
0
5
10
15

MAR 31 1904

Report on Trawling and other Investigations carried out in the Bays on the South-East Coast of Devon during 1901 and 1902.

PREPARED FOR
THE INFORMATION OF THE DEVON SEA FISHERIES COMMITTEE.

By
Walter Garstang, M.A., F.Z.S.,
Naturalist in charge of Fishery Investigations.

(*With one chart.*)

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INTRODUCTION.

THE investigation of the trawling-grounds in Start Bay, Torbay, and Teignmouth Bay, which had been previously investigated in 1895–8 by Messrs. Stead * and Holt,† was resumed by the Marine Biological Association in 1901, under authority from the Devon Sea Fisheries Committee.

---

* Stead, "Preliminary Note, etc.," *Journ. M. B. A.*, iv., 1896, pp. 90–6.
† Holt, "Report on Trawling, etc.," *Journ. M. B. A.*, v., 1898, pp. 296–329.

The new investigations were placed in the hands of Dr. H. M. Kyle, on his appointment as Assistant Naturalist to the Association, and were carried out by him at nearly regular monthly intervals from the end of July, 1901, to the beginning of September, 1902, by means of the Association's s.s. *Oithona*, and with the assistance from time to time of various members of the staff, especially Mr. Todd. Mr. L. W. Byrne, during his visits to the Plymouth Laboratory, also volunteered his assistance in the work at sea on several occasions.

In addition to the trawling investigations, Dr. Kyle arranged for the collection of special statistics dealing with the Brixham fisheries. These covered the period from the beginning of February, 1902, to the end of January of the current year.

The manuscript of Dr. Kyle's report was received in March, but owing to difficulties in the work of revision which supervened after Dr. Kyle's removal to Copenhagen, I received instructions from the Council of the Association to draw up a new report, embodying as much of Dr. Kyle's manuscript as might be possible, which accounts for the delay which has taken place in the publication of the results. With the exception of the tables dealing with the reproduction of the plaice, which were prepared by Dr. Kyle, the figures representing the *Oithona's* work in the present Report have all been compiled under my supervision direct from the original log-books. Mr. T. C. Jerrom was appointed to assist me in this work, and I have much pleasure in acknowledging the care and accuracy in detail with which he has carried out his task. The special statistics of the quantities of fish landed at Brixham have been retained in the form in which they were submitted by Dr. Kyle, except for the correction of some insignificant arithmetical errors.

SECTION I.

The Brixham Fishing-Grounds and Fishery Statistics.

By

H. M. Kyle, M.A., D.Sc.,

Late Assistant Naturalist to the Association.

(*With Table A at end.*)

There was a time, and that not many years ago, when the fishing-boats of Brixham sailed round to the east coast of England and joined with the fleets of London, Lowestoft, Yarmouth, and Grimsby in exploiting the fishing-grounds of the North Sea.* This carries us back at least two generations, but if one chose to hunt through old records, one might find mention of Brixham and its fishing many centuries ago.† The records may even go back to an earlier date than the Armada, but its past history, though of exceptional interest, is of no importance to our present purpose, and we may turn to the doings of the men of Brixham at the present day.

Even a casual visitor to this port of South Devon would notice at once that the big boats are of two distinct types and sizes, the larger ones ketch-rigged, the smaller mostly with the cutter rig, and this would suggest differences in the size of gear employed and in the fishing-grounds visited by each. The large boats are over fifty tons burden, intentionally under-rigged, and able to go anywhere and stand any sea short of that raised by a hurricane. The trawl they use is of forty-five to forty-seven-foot beam. The small boats mostly run about twenty-five tons, and in unsettled weather cannot venture more than a few miles from land. Their trawl has only a thirty-six to forty-foot beam. Between these two types of boat there is a third of about thirty tons, which from the fact of its being modelled on the boats of Ramsgate is, like them, called a "Tosher." Very few boats of this type, however, exist at Brixham.

---

* For the place which Brixham has taken in the development of the North Sea fishing, see E. W. L. Holt, *Journ. M. B. A.*, vol. iii. p. 363.

† See Holdsworth, *Deep Sea Fishing*, who suggests that Drake used the Brixham men and boats against the Spaniards.

The large boats, generally called the smacks or dandies, formerly journeyed every year to the North Sea, but some twelve years ago they were crowded out by the ever-increasing fleets of Lowestoft, Yarmouth, and Grimsby. Some of the men remained at these ports, and have aided in making them great fishing centres, but the majority turned in the opposite direction, and as the English Channel was seemingly not rich enough to support all, they made their way into the Bristol Channel. There they discovered new and exceedingly rich trawling-grounds, and year by year they have continued to pass round Land's End in early spring, gradually extending their field of operations along the North Cornwall, Welsh, and Irish coasts as far north as the Irish Sea, and opening up new fishing centres, as Milford and Dublin, wherever they went.

Since the majority of these boats are away from Brixham for the greater part of the year, and mostly land their fish at other ports, it is impossible to obtain even an approximate measure of the value of the grounds on which they fish. Some impression of their richness may, however, be obtained from the quantities of soles occasionally sent over to Brixham by rail from Padstow in North Cornwall.

During March, 1902, 12,700 pairs of soles.
„ April „ 17,400 „ „
„ May „ 8,300 „ „

The ground on which these are caught, said to be very coarse and rough, is called by the fishermen "ross"-ground on account of the hard masses of Lepralia and of Alcyonium on shells, which abound there. Plaice, turbot, and rays are also caught in considerable quantities, but the distinctive feature is undoubtedly the large supply of soles.

As the boats move further up the Bristol Channel and on to the Welsh grounds, their catches are quite lost to Brixham, which renders it impossible to give even a sample of what they obtain. According to all accounts, however, the characteristic of the fishing is still the great capture of soles.

Whilst the majority of the smacks spend the greater part of the year on the west coast, a varying number remain nearer home, and in the autumn all the boats are fishing in the English Channel. The grounds they work over extend from Portland to Land's End, usually between the twenty- and forty-fathom lines. The nature of the grounds is practically the same throughout, and is of coarse sand, shell, and gravel, with patches of stones and occasionally fine sand. As may be imagined, the catches consist largely of rays, red gurnards, and the prime fish—soles, turbot, etc. Sometimes the turbot seem to be exceedingly abundant, as during the past autumn, and in certain places, *e.g.* Mount's Bay, large quantities of plaice and soles are caught in their seasons. On the rough patches, off the Start and off Portland, the liners ("bolters") procure great hauls of conger, cod, ling, and rays. Since the smacks frequently land their catches at Plymouth, or at various ports in the south of Cornwall, it has been found impossible to give even an approximate measure of the value of the grounds in question. That these are rich and valuable there can be no doubt, for they support the Plymouth sailing-trawlers all the year round as well as frequent steam-trawlers from French and English ports. But the roving instinct of the Brixham fisherman, as well as his desire for greater gains, leads him to prefer the Bristol Channel.

We come lastly to the home grounds and the small trawlers. A few of the large smacks fish on these grounds occasionally in the intervals of coming from and going to the Bristol Channel; but they may be neglected for the present until we have discussed the fishing of the small boats. These number about seventy, and are known locally by the peculiar term "Mumble Bees," said to be derived from a small fishing village called Mumbles, near Tenby in Wales. Some of the fishermen who went round to the Bristol Channel found at Mumbles this smaller type of boat, cutter-rigged and about twenty-five tons, and adopted it for the inshore fishing near Brixham. It follows that the Mumble Bees are a comparatively recent innovation, though it must not be supposed that there were no small trawlers at Brixham before their introduction. As a matter of fact, there was a smaller class of boat, under five tons and without deck, which still persists at that port and other places round the coast, but they are for the most part employed in hooking or lining at the present time.

The fishing-grounds of the Mumble Bees lie within the area Start Point to Portland (see chart). If a line were drawn from Start Point six miles to the south-east, thence to the inner edge of the "Scruff" and on to Portland, it would embrace the region beyond which the Mumble Bees seldom venture. The line would enclose about 700 square miles of sea, little more than one-half of which is worked by the trawlers. Rocks prevent trawling within the fifteen-fathom line from the Orestone off Torbay right to Portland, and there are several rocky patches off Downend, *i.e.* between Berry Head and Start Point. The trawlable area is thereby reduced to less than 400 square miles, and 70 square miles have been further cut off by the closure of the inshore grounds—that is to say, the proportion of the enclosed grounds to the outside trawlable area is about one-fifth.* Before the closure of the bays the outside trawling-grounds were more restricted, but since that time the fishermen have been driven by force of circumstances to trawl on grounds they had never before frequented.

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* The proportion is less in reality, because the crab-pots on the Skerries Bank and the rocks closer inshore cut off one-third of Start Bay as a trawlable area. The proportion of trawlable area within the enclosed waters to that outside is therefore about one-sixth.

The various parts of the trawling area are fairly well differentiated from one another by the bottom-soil, and are known to the fishermen by distinctive names. Along the northern portion, in fifteen to twenty-two fathoms, lies the "Spion Kop" ground, so called by the Brixham men from some fancied resemblance of the promontories along the coast to the famous battlefield in Natal. The soil is composed of medium to fine sand, with coarse patches here and there. Pectens (queens) and other shell-fish are abundant, and the ground is liable to become very foul by sudden incursions of star-fishes, sea-urchins, and drift-weed. How these can suddenly appear and as quickly disappear within a few days is one of the unsolved mysteries of the region.

The Brixham men did not trawl on this Spion Kop ground till three years ago, and visit it only during the spring. At that season the plaice are returning to the inshore waters, and this is one of the main lines of the migration. The plaice are not large, and last year (1902) they were said to be smaller on the average than in previous years. Soles are also obtained there, likewise whiting, dabs, and gurnards; but the mainstay of the fishing is the plaice.

To the south-east of the Spion Kop ground lies the "Biscuit Dust" ground, twelve miles off Berry Head and running up to within six miles of Portland. It is so called from the bright golden yellow colour of the coarse sand and shells which compose its soil. Starting at about twenty-seven fathoms, it extends out to thirty fathoms, where it merges into the "Scruff." The fish obtained here are plaice at the spawning time in early spring, soles, rays, and sometimes in the autumn considerable quantities of red mullet.

The Scruff is not a regular trawling-ground, its coarse soil and "hummocky" nature being too dangerous, especially for the comparatively light materials of which the small trawlers' nets are made. The large smacks with their stronger nets of manilla might tow over it, and at the eastern corner the liners often procure large catches of ling and rays. At the western end of the Scruff, however, lies a favourite trawling-ground, especially in late spring, when fine catches of whiting are often obtained.

Following along the line of the Scruff, towards Start Point, we come to the "Corner," which in late spring and summer is the rendezvous of all the small trawlers. It lies across the thirty-fathom line, six to ten miles off Dartmouth Fairway with Prawle Point clear of Start Point. Fish are abundant there during the season, and include soles, lemon-soles, a few turbot, plaice, dabs, whiting, gurnards, and rays; in fact, it is the richest ground within the area. The invertebrate fauna is also rich and distinct from that of the other grounds. The crabs Polybius, Atelecyclus, Corystes, and the heart-urchin Echinocardium are more plentiful here than anywhere else.

The central region of muddy ground has no particular name, but is well fished over at all seasons of the year for the sake of the ubiquitous whiting. Along the western margin of the area there are several well-known trawling-grounds, *e.g.* "New Ridge," off Downend, and the "Hitches," off Berry Head, which really form part of the central region, and require no special mention.

Although the grounds are so distinct from one another that an expert salesman can tell where a catch of fish has come from, it has not been thought of any practical importance to distinguish them in the statistics. Also, as the Mumble Bees rarely go beyond the limits mentioned, it has been a comparatively easy task to obtain an approximate measure of the value of these grounds. A few small trawlers from other ports—Torquay, Exmouth, Beer—fish on the same grounds, but the quantities they catch are quite negligible. The same cannot be said, however, with regard to the large Brixham smacks which occasionally fish within the area, and their catches require to be taken into account.

An explanation may now be given of the method by which the data of the boats' catches have been obtained. As is generally recognised, it is by no means easy to collect statistics which will give precise information on any points other than those considered in the returns of the Board of Trade, for the simple reason that the mode of selling fish determined by custom and practice is in no way suited to theoretical requirements. It would be absurd to expect the fishermen and fish salesmen to alter their customs, and that in several and diverse directions, since theoretical requirements are many; so one is obliged to make the best compromise possible between what one wishes and what one can get.

The practice of the Brixham Mumble Bees in arranging their fish for sale is somewhat different from that employed on the east coast, where the fish are carried ashore in large baskets or panniers, and then put into a standard size of box, or arranged in lots. At Brixham the large boats treat their fish in the latter way; but the small boats, which carry no ice, and are only fishing for a day or two at a time, have them packed and ready for sale before landing. When the trawl is emptied on deck after a haul the smallest fish and the useless species are thrown overboard; the prime fish—soles, turbot, etc.—are laid apart, and the large fish of the remaining species (offal), as plaice and whiting, are separated from the small and placed in the trunks, whilst the small fish are packed into small baskets. A larger basket, called a "maund," is occasionally employed by the Mumble Bees when they have a few large fish, but not sufficient to fill a trunk. On the other hand, the maund is the only small basket which the large smacks employ.*

As the fish are sold in trunks and small baskets, it might be thought a simple matter for an expert to tell the quantities of large and small fish. As a general rule this is the case, and the size used by the fishermen to distinguish large from small, *i.e.* the fish of the trunks from those of the baskets, agrees closely with a standard chosen for a special purpose of the present research. As shown in describing the fishing-grounds, whiting form the staple support of the fishermen for the greater part of the year, and if we omit the prime fish, plaice rank next in importance. Of the whiting and plaice, all below 8 inches are thrown overboard, those between 8 and 11 inches are packed in the baskets, and those over 11 inches in the trunks. Sometimes the small are placed in trunks when very numerous; this happens most often with whiting, but not so frequently with plaice. On the other hand, some larger plaice are often packed into the small baskets when too few to make up a maund, and they may be taken to counterbalance the small plaice packed in the trunks. This has been done in the present work, and it may be remarked that this method of forming an estimate lessens the number of small plaice rather than the large ones.

Sometimes also small plaice, when too few to fill a separate basket, are packed in the same basket with dabs and flounders, and similarly the whiting with gurnards. Their number is, however, negligible, as plaice and whiting are the best of the "offal," and it would be bad policy on the fisherman's part to mix them with the others.

The difficulties of obtaining the numbers of small and large plaice and whiting reduce themselves therefore to those of simple enumeration. When a large quantity of fish is landed at one time there is some difficulty in counting all the baskets and trunks, but as a general rule the task is a comparatively easy one.

The only other species which has been taken into account is the sole. The quantities landed of this fish are readily obtainable, as they are always spread out on the ground in pairs.

Plaice, soles, and whiting were chosen for special investigation, for the reason that they are by far the most important species; and, further, since the work was entirely new, and at first of considerable difficulty, it was considered more desirable to obtain definite information with regard to a few species than imperfect records of many.†

* The maund, four of which are equal to a trunk, is so seldom employed by the Mumble Bees that it might have been disregarded, but where it occurred in the statistics it has been converted into its equivalent in trunks.

† Mr. Will Sanders, a trustworthy fish salesman of Brixham, recorded the daily returns of fish landed. Although the information is definite, no claim is made that it is perfect. There are several shortcomings in detail. . . .

To begin with the plaice, Holt, in his *Examination of the Present State of the Grimsby Trawl Fishery*, p. 409, has given the numbers of plaice that a trunk will hold. He takes 250 as being the average number of plaice under 12 inches; for larger fish the numbers are considerably less. These numbers apply to the North Sea plaice, and it appears that 9 stone is about the average weight of a full trunk. For the plaice landed at Brixham these numbers are somewhat too high; a full trunk only averages about 7 stone, and the numbers vary from 60 or 70 to 200, according as the plaice are 16 to 18 inches on the average or 10 to 12 inches. After counting and weighing the contents of several trunks the number chosen as best representing a trunk was 90,* and the figures in the following tables are based on this.

As the small baskets contain plaice of approximately the same size, there is much less difficulty in finding a number which represents the average they contain. In the following table 25 is employed. The sizes which go into the small baskets are from 8 to 10 inches in the great majority of cases; but as plaice over 10 inches are often sold with those under 10 inches, 11 inches has been the limit chosen.

In the accompanying Table I. the actual numbers of plaice landed by the Mumble Bees † are tabulated for each month of the year. Inasmuch as some of the larger smacks are at times working on the same grounds—namely, between Start Point and Portland—the numbers of plaice captured by them have been added at the end of each quarter.‡

The total number of "large" plaice obtained during the year amounts to 180,180. Of this number more than half were captured during February, March, and April, when the plaice were spawning in the deep water or returning to the inshore grounds after having spawned. The months when the larger fish are least abundant offshore are September, October, and November. It is worthy of remark that the numbers for the months rise from 360 in November to 49,860 in April, and descend again to 450 in October in an almost uniform manner.

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* This number was partly based also on the estimate that the average weight of plaice was 1 to 1½ lbs. All the factors stated here—for whiting and soles as well—require further testing.

† The plaice landed at Torquay by the Brixham boats have been omitted. The effect is that the numbers of the small plaice are lower than they might have been. The Brixham boats land their catches at Torquay in the summer-time only. I do not think the omission amounts to more than one or two per cent. of the numbers recorded in the table, and the conclusion as regards distribution of small plaice is quite unaffected.

‡ The returns of the large boats were also taken daily by Mr. Will Sanders, but as they are comparatively few in number, their importance is sufficiently recognised in merely stating the total number of plaice captured by them during each three months.

TABLE I. *Numbers of Plaice captured by Brixham Fishing-Boats on the Grounds between Start Point and Portland, with proportions of small to large.*

(Abridged from Table A, p. 501.)

Month.	No. of Plaice under 11 inches.	No. of Plaice 11 inches & over.	Proportion of small to large.
February, 1902	4,325	22,590	19 : 100
March ,,	4,375	20,700	21 : 100
April ,,	19,800	49,860	40 : 100
Total for three months	28,500	93,150	30 : 100
Plus number captured by large smacks	1,225	4,365	28 : 100
Grand total for three months	*29,725*	*97,515*	*30 : 100*
May, 1902	4,350	12,420	35 : 100
June ,,	8,850	14,760	60 : 100
July ,,	9,650	10,710	90 : 100
Total for three months	22,850	37,890	60 : 100
Plus number captured by large smacks	2,950	6,705	44 : 100
Grand total for three months	*25,800*	*44,595*	*58 : 100*
Total for the six months, February to July	**55,525**	**142,110**	**39 : 100**
August, 1902	10,650	2,250	473 : 100
September ,,	6,550	1,260	519 : 100
October ,,	6,800	450	1,511 : 100
Total for three months	24,000	3,960	606 : 100
Plus number captured by large smacks	16,875	2,070	815 : 100
Grand total for three months	*40,875*	*6,030*	*678 : 100*
November, 1902	8,350	360	2,319 : 100
December ,,	6,700	2,700	248 : 100
January, 1903	10,250	7,920	129 : 100
Total for three months	25,300	10,980	230 : 100
Plus number captured by large smacks	21,375	21,060	101 : 100
Grand total for three months	*46,675*	*32,040*	*146 : 100*
Total for the six months, August to January	**87,550**	**38,070**	**230 : 100**
Total for the year, February, 1902, to January, 1903	*143,075*	*180,180*	*79 : 100*

The most remarkable fact which this table reveals is the large number of small plaice which are captured in the deep water, not merely in one month or season, but throughout the year. The largest number—that recorded in April—is 19,800, but those for the other months vary between 4,000 and 10,000. On account of this uniform distribution throughout the months, the numbers of small plaice are sometimes greater and sometimes less than those for the large plaice. They are less from February to July, and greater from August to December. The proportions of small to large are stated in hundredths in the third column. The fluctuation in these proportions—from 19 in February to 2,319 in November—is simply another expression of the varying supply of large fish.

The number of small fish landed for the year is a little over 143,000. The total number of plaice, large and small, is about 323,000, and of these the small plaice amount to 44 per cent. The records for the large smacks suggest that the small plaice may be relatively more abundant some distance from land than inshore, as the smacks always fish further out to sea than the Mumble Bees. Fifty-three per cent. of all the plaice landed by these large boats consisted of small fish.*

When we pass later to a comparison of the offshore fishing-grounds with Start Bay, it will be shown how important is the fact that the small plaice under 11 inches are distributed over the offshore grounds. We find similar phenomena in the North Sea off the Dutch coast to the east of the Dogger Bank † and elsewhere,‡ so that to naturalists the fact will come as no surprise.

Though the plaice is of higher importance for the purposes of the present paper, it is of less value to the Brixham Mumble Bees than the soles or whiting. The whiting is undoubtedly the most abundant species and the one on which the fishermen are mostly dependent. Some notion of the numbers caught throughout the year may be obtained from the subjoined tables. Accuracy is not claimed for these figures, because the approximations made are even greater than in the case of the plaice. As with the latter, whiting are brought to market in trunks and small baskets. Their size varies from 9 to 17 inches, and all sizes may be placed in the trunks, whilst the small baskets seldom contain any over 11 inches. It is necessary, therefore, to state the proportion of small whiting which are placed in the trunks.

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* It must be admitted that there is a possibility of error in these records for the large smacks, owing to the fact that the plaice landed by them are mostly in small quantities at a time and all sizes are mixed together. The percentage of small fish may therefore be a little lower than that stated.

[It must also be borne in mind that, while the number of Mumble Bees is practically constant throughout the year, the smacks work in greater numbers in the autumn than in the spring period ; *i.e.* their hauls are most numerous in the season when the small fish predominate. I cannot on this account share my colleague's opinion that the figures suggest a higher proportion of small fish to large on the grounds worked by the smacks than on those worked by the Mumble Bees. On the contrary, the quarterly ratio of small fish to large is seen in the table to be lower for the smacks than for the Mumble Bees in each quarter except the third. In that quarter it is much less than the ratio yielded by the catches of the Mumble Bees for the last month in the quarter, viz. October, and it was during this month that the smacks appear to have increased in number.—W. G.]

† See E. W. L. Holt, *Journ. M. B. A.*, vol. iii. p. 405.

‡ Mr. J. T. Cunningham, *Journ. M. B. A.*, vol. iv. p. 24, has already remarked on the presence of small plaice over the area described in these pages, but records no actual observations. (Mr. Garstang kindly pointed out this reference to me.)

The following proportions are based on personal experience and checked by information from fishermen and fish buyers. The whiting may be divided into three classes—"small" from 9 to 11 inches, "medium" from 11 to 14, and "large" above 14 inches. Only the small are placed in the baskets, each of which holds 36 on the average. The great majority of the fish in the trunks are also small, and in the tables one half of the trunks are allocated to the small fish, the multiplier used being 350.* The resultant product is added on to the quantity in the small baskets, and the total given in the last column.

Large whiting are never very plentiful nowadays, and it has been calculated that they are adequately represented by $\frac{1}{10}$th of the trunks. A trunk contains about 130 large whiting, so that the numbers in the second column are obtained by dividing the number of trunks by 10 and multiplying the remainder by 130, or more simply by multiply-the number of trunks by 13. When $\frac{6}{10}$ths of the trunks are thus disposed of for the small and large whiting, $\frac{2}{5}$ths remain for the medium-sized. A trunk holds from 150 to 250 medium-sized whiting, and the number chosen as the average is 200. Consequently if the number of trunks be multiplied by $\frac{2}{5} \times 200$, or more simply by 80, we get the total number of medium-sized whiting.

The numbers of whiting given in Table A speak for themselves; it is only necessary to mention that the great decrease during March to June is at the spawning time. It thus appears that the whiting are in mid-water, or, at least, not on the bottom when spawning. For the rest of the year the numbers per month are fairly constant, the highest record being in December (over 700,000) and the lowest in February (315,000).

There is little difficulty in ascertaining approximately the number of soles landed day by day, because, as already stated, they are laid out in pairs on the market. The data in Table A may therefore be regarded as fairly accurate. Few soles were obtained during March and April, and as these months form their spawning season it seems that, like the whiting, they disappear temporarily from the grounds where the Mumble Bees work. It is possible that they may be swimming up in the water more at that time than at others, but they may be further offshore in deeper water or on rough ground, *e.g.* the Scruff, where the Mumble Bees cannot get at them. It is well for the fishermen that the plaice are abundant during the months when soles and whiting are scarce.

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* That is to say, each trunk is taken to contain 175 small whiting on an average.—W. G.

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The important points displayed in the present section may be briefly summarised. The trawling area over which the Mumble Bees work is about 400 square miles. This area is divisible into a number of separate trawling-grounds, each of which has its "season." The most valuable species of food-fishes are the soles, whiting, plaice, in the order named. The proportion of small plaice on the offshore grounds is considerable, 44 per cent. of all the plaice captured being under 11 inches.

SECTION II.

Distribution and Migrations of Food-Fishes.

By

Walter Garstang, M.A., F.Z.S.

1.—TRAWLING INVESTIGATIONS.

(*With Tables B, C, D, E at end.*)

The trawling investigations in the bays were carried out at monthly intervals by means of the Association's steamer *Oithona*, a small yacht of 69 tons gross tonnage. Only one gap appears in the monthly records for Start Bay (March), and three in those for the other bays. The total number of hauls recorded in the tables is 138, viz. 70 for Start Bay, 36 for Torbay, and 32 for Teignmouth Bay. A few hauls were made on the offshore grounds, but they were not sufficiently numerous to furnish a basis of comparison with the inshore records. Their publication is therefore deferred.

During the previous investigation of the bays by the Association in 1895–8, already reported on by Messrs. Stead and Holt, operations were much hampered by the lack of a suitable steamer, and only 45 hauls in all were recorded. These, however, included a number of hauls by the Brixham smack *Thistle*, so that the actual numbers of fish dealt with in the former report fell not far short of those included on the present occasion, *e.g.* 5,467 plaice as against 6,089.

The apparatus employed during the *Oithona's* work is described more fully by Dr. Kyle in a separate paper.* It was a form of otter trawl specially adapted to the Brixham grounds. For greater lightness the twine employed was cotton, not manilla as in the ordinary otter trawl, and the mesh throughout was graded as in the trawls of the Brixham Mumble Bees. There has been no essential change in the structure of the nets of the latter since Mr. Holt carried out his investigations; and as the mesh of the trawls used by him was of a similar character, the present records are directly comparable with his, so far as regards the proportions of large and small fish. The differences between the nets, in regard to their total catching power, will be adverted to below in the discussion of the results.

The work at sea consisted in the enumeration and, with few exceptions, the measurement of all the fishes caught. During 1901 the measurements were recorded to the nearest half-inch, but during 1902 to the nearest half-centimetre. Experiments with marked plaice were also undertaken, as a means of studying the migrations of this fish.

In the present report the original measurements have been converted into inches, in order to facilitate comparison with Mr. Holt's results; but in the case of the marked fishes the original records in centimetres have been retained, owing to the greater convenience of this unit for comparisons of a minuter character.

The selection of the trawling stations was left entirely to Dr. Kyle, who is also responsible for the accuracy of the identifications and measurements, and for the general conduct of the work at sea. My own part has been limited to the tabulation and analysis of the records, and to the formulation of such conclusions as appeared to be substantiated by the facts and to be relevant to the main questions before the Devon Sea Fisheries Committee as to the advantage or disadvantage to the fishery of the closure of the bays to trawlers.

It will be convenient, before proceeding to details, to present a summary showing the general characteristics of the three bays as regards distribution and abundance of the chief kinds of fish. The following table has been prepared from Dr. Kyle's records, and represents the sum of the *Oithona's* catches of each species throughout the year, reduced to the average catch for one hour's fishing. This procedure is necessarily somewhat drastic, especially in the case of seasonal migrants, and in the case of the less common forms it naturally reduces the numbers in many instances to mere fractions. Where this fraction exceeds 0·5 it has been treated as 1; in cases where it is less than 0·5 the plus sign has been inserted in place of the fraction to indicate the occasional presence of the fish. The minus sign, which is also employed, indicates entire absence so far as our records show.

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* Kyle, "Fishing Nets, with Special Reference to the Otter-Trawl," *Journ. M. B. A.*, this number, p. 562.

The fish have been classified as "small" and "marketable" according to the limits assigned in the table for each species. The dimensions are those of total length, except in the case of the rays (Thornback, Homelyn, and Blonde), for which the maximum breadth has been substituted.

TABLE II., *showing, for each of the bays, the Average Catch per Hour of the Chief Fishes, distinguishing the small fish from those of marketable size.*

	Size of "small" fish. Below	START BAY.			TORBAY.			TEIGNMOUTH BAY.		
		Total.	Small.	Marketable.	Total.	Small.	Marketable.	Total.	Small.	Marketable.
laice	8 ins.	19	1	18	38	19	19	38	23	15
abs	8 ins.	23	13	10	61	55	6	13	9	4
lounder	8 ins.	+	−	+	2	−	2	+	−	+
ole	8 ins.	1	+	1	1	+	1	2	+	2
rill	10 ins.	1	+	1	+	+	+	1	+	+
rey Gurnard	8 ins.	10	5	5	4	4	+	3	3	+
hiting	8 ins.	2	+	2	5	4	1	5	3	2
ory	8 ins.	2	+	1	+	+	+	+	+	+
hornback	12 ins.	1	1	+	9	8	1	16	10	6
omelyn	12 ins.	1	1	+	+	+	−	+	+	+
londe	12 ins.	4	2	2	+	+	−	+	+	+

The table shows at a glance that, if both size and numbers are taken into consideration, the **Plaice** is the dominant fish in each bay, and that the fish which competes with it most closely in abundance is the **Dab**, the small size of which, however, renders it of little commercial value. The **Grey Gurnard** and **Whiting** occur in each bay, though mostly of small size, and in insufficient numbers to be of much value to the fishermen. The **Thornback** ray attains a certain measure of importance in Teignmouth Bay, but in Torbay it is represented mostly by small specimens, and in Start Bay it is virtually replaced by two other species, the **Homelyn** (or spotted ray) and the **Blonde**, which are practically absent from Torbay and Teignmouth Bay. The **Brill** is less rare in Start Bay than in the others, and the **Sole**, though present in all the bays, only approaches importance, in point of numbers, in Teignmouth Bay.

It will be seen that, speaking generally, Torbay occupies a position biologically as well as geographically between the other bays. It stands somewhat nearer to Start Bay than to Teignmouth Bay as regards its numbers of marketable plaice, but it shows a still closer resemblance to Teignmouth Bay than to Start Bay in the abundance of small plaice within its limits. The peculiar feature of Torbay is the abundance of small dabs, which distinctly outnumber the plaice. In Start Bay, also, these fishes are numerically in excess* of the plaice, though slightly, and a far larger proportion of them attain the marketable size. In Start Bay alone are the marketable plaice in excess of the small ones, and these they outnumber by eighteen to one.

The problem of the bays, so far as it is a biological one, clearly hinges upon the plaice, and in the succeeding sections our records of the distribution and sizes of this fish have been accordingly subjected to a much closer analysis than those of the other species.

START BAY.

The following description of the trawling-grounds has been provided by Dr. Kyle:—

"The area closed by the by-laws includes about twenty-five square miles, but owing to the presence of crab-pots on the Skerries Bank and of rocks along the shore, the trawling-grounds are reduced to fifteen square miles. The bottom-soil is of three distinct kinds. Coarse sand to gravel is found along the shore from Blackpool to Hallsands, extending outwards about a hundred yards off the former; but off Hallsands it stretches right round the promontory, and extends outwards to join on to similar soil along the inner and outer margins of the Skerries. In the centre of the bay the soil is of medium to fine sand, whilst round Dartmouth Fairway it is of mud. As mentioned in a separate paper, storms make considerable alterations, for the time being, in the distribution of the various soils throughout the bay. During neap tides there is very little movement of the water in the centre of the bay, but during spring tides a current of two to three knots runs through it. This is stronger on the ebb and alongshore, where a two and a half to three hours' eddy on the latter half of the flood makes with the ebb a nine hours' current flowing from Slapton Sands to the Point. The presence of this current is of considerable importance, as it prevents the bay from becoming foul with drift-weed, mud, jelly-fishes, diatoms, etc., a fate which periodically overtakes the other bays during the summer. For this reason the sand of Start Bay is particularly clean and bright-coloured, and the plaice which live there have the same qualities. The brightness of their orange-coloured spots and the shiny appearance of their skin readily distinguish them from those of any other region. It is probable, also, that the general cleanliness of the bay has some influence for good on the invertebrate fauna which constitutes their food; certainly the plaice from Start Bay used to obtain the highest price on the market.

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* As shown below (p. 458), this excess, in the case of Start Bay, was limited to the summer season of 1902, when, however, the preponderance of dabs was very conspicuous.

"The rocks which break up the trawling area of the bay lie in the south-west corner off Hallsands and Beesands and along the northern shore from Blackpool to the Mewstone on the far side of Dartmouth Fairway. To the south-west of Blackpool is a further patch of rocks, and off Torcross there is a shelving bank of slate-rock, running about a mile out to sea, with several isolated rocks near it. Since all these lie within or close to the zone of the coarse sand, and the plaice prefer this kind of soil, it may be well understood that the largest and strongest plaice are safe from the trawler, except when they are migrating from one region to another. There are one or two passages between the rocks close inshore, as well as open spaces at Blackpool and along Slapton Sands, and it is on these grounds that the large plaice are obtained.

"The inner passages are only known to the older fishermen who worked in Start Bay before the by-laws came into force, and the *Oithona* could not work there. The largest plaice are not truly represented in the statistics for this reason, and their presence would have remained unknown had we not ventured on several occasions to trawl closer to the rocks than was altogether good for the nets."

The total number of hauls of the trawl recorded for Start Bay amounts to seventy, and, as may be gathered from Table E, they were distributed through the successive months of the year with fair uniformity, the only month which is altogether unrepresented being March. Since the ground varies in character in different parts of the bay, the hauls have been classified into four stations, which approximately correspond with these natural distinctions. They have been defined as follows:—

Station I. The central and north-eastern parts of the bay. In practice an attempt was made to distinguish between these two parts as follows:—

Sub-station (i). "Centre of the bay; along the line Mewstone Rock, to the east of Dartmouth just inside Downend Point, to Freshwater Bay near Start Point. The trawl was shot in 12 to 15 fathoms, and lifted as a rule in 8 to 9 fathoms after passing Torcross. The bottom-soil is mud to fine sand" (H. M. K.).

Sub-station (ii). "The north-eastern triangle of the Bay, formed by the Mewstone, Blackpool, and Skerries Buoy. The depth varies from 10 to 20 fathoms, and the bottom-soil is for the most part mud" (H. M. K.).

The hauls referred to these sub-stations by Dr. Kyle have been distinguished in the detailed list of hauls (p. 503); but they have not been separated in the summary tables, since considerable overlapping took place, and the general results of the work on the two sub-stations were practically identical. As Dr. Kyle remarks, "they display the general or average condition of the bay, omitting the Skerries Bank."

Station II. "Along Slapton Sands, [usually] in 6 fathoms. The bottom-soil is here coarse sand" (H. M. K.). Occasionally the haul was made in 7 to 8 fathoms (No. 19), or extended to 10 fathoms (No. 8). "The hauls on Station II. were made, for the most part, in summer, when the plaice are inshore; during winter this ground is almost devoid of fish of all kinds" (H. M. K.).

Station IIa. "This represents the trawling-ground from Start Point to off Torcross. It means skirting the rocks at the latter place, so that no further comment need be made on the fact that only one haul is recorded" (H. M. K.).

Station III. "Along the inner margin of the Skerries Bank. The depth varied from 5 to 10 fathoms, and the soil is also coarse sand" (H. M. K.).

The biological features of the different stations may be gathered from the accompanying table, which represents the *Oithona's* average catch per hour for the whole year on the different grounds.

TABLE III., *showing Average Catch per Hour for the entire period on the various stations in Start Bay.*

Species.	Station I.				Station II.		Station III.		Station IIa.		Totals.				
					19 hrs.	15 min.	15 hrs.	50 min.	0 hrs.	40 min.					
	hrs.	min.	Small.	Marketable.	Small.	Marketable.	Small.	Marketable.	Small.	Marketable.	hrs.	min.	Small.	Marketable.	Total.
Plaice . .	101	10	+	18	2	21	+	14	–	71	136	55	1	18	19
Dabs .	88	10	13	10	14	9	+	5	–	12	123	55	13	10	23
Sole . .	92	10	+	1	+	2	–	+	–	1	127	55	+	1	1
Brill . .	92	10	+	+	+	+	–	4	–	1	127	55	+	1	1
Grey Gurnard	88	10	5	5	10	6	+	2	–	4	123	55	5	5	10
Whiting .	92	10	+	2	+	+	–	+	–	–	127	55	+	2	2
Thornback .	89	10	+	+	3	+	+	–	6	4	124	55	1	+	1
Homelyn .	85	15	+	+	1	–	+	–	7	–	121		1	+	1
Blonde . .	85	15	1	1	+	–	11	11	–	1	121		2	2	4

The difference between Stations I. and II. is one of degree rather than of kind, and is for the most part due to differences in depth. It will be seen that plaice were somewhat more abundant on the inshore grounds than on Station I., and it was only on the former station that small plaice were present in appreciable numbers. Small dabs were also slightly more abundant on Station II. than on Station I., and large dabs slightly less numerous. Thornback and homelyn rays were more plentiful on Station II. than Station I.; while blondes, both large and small, were more plentiful on Station I. Station III., which corresponds with the Skerries Bank, is seen to possess distinct features. "It is characterised," as Dr. Kyle remarks, "by the numbers of large brill and blondes (rays) found nowhere else in such abundance over the whole fishing area of the Mumble Bees. The plaice obtained here are also large, but there is a comparative absence of soles, dabs, gurnards, and other species."

Station IIA. is characterised by the general absence of small fish, and by the large size of the flat-fish which occur upon it. Only one haul of the trawl, however, is recorded for this station.

In order to represent the seasonal differences in the fishing of Start Bay it will be necessary to combine the records of all four stations, since there is a considerable amount of migration within the bay at different seasons from the shallower to the deeper parts and *vice versâ*. In view of the differences which the preceding table reveals, it will readily be understood that combinations of the results of trawling over these different stations will not be strictly comparable with one another unless the different stations are represented in each combination in equivalent proportions. In practice, the maintenance of any fixed proportional representation of the different stations throughout the monthly investigations was not found to be practicable. It is necessary, therefore, before proceeding to discuss the seasonal differences observed, to note the actual duration of trawling over the different stations in each season of the year. These details are provided in the following table:—

TABLE IV., *showing the Amount of Trawling over each station in Start Bay for each quarterly period of the year.*

Season.	Station I. No. of hrs.		Station II. No. of hrs.		Station IIA. No. of hrs.		Station III. No. of hrs.	
	hrs.	min.	hrs.	min.	hrs.	min.	hrs.	min.
July, August, September .	9	25	7	45	—		6	0
October, November, December	38	25	7	55	0	40	5	20
January, February	9	15	—		—		1	30
April, May, June	27	55	1	0	—		3	0
July, August	14	40	2	35	—		—	
October	1	30	—		—		—	
TOTALS	101	10	19	15	0	40	15	50

It will be seen that during the first quarter Stations II. and III. received considerable attention as compared with Station I., but that in succeeding quarters Station I. was investigated far more extensively than the remaining grounds. The hauls on Station III. ceased after April, 1902.

SEASONAL CHANGES.

Although it is possible by an examination of Table E to obtain some general ideas as to the effect of the seasons on the numbers and distribution of the plaice in the bay, it is necessary to condense the results in order to grasp the chief features in these changes. Table F provides a series of monthly summaries showing the total catch, the catch per hour, and the percentage frequencies of the fish of different size. The limits between the various size-groups are the same as those previously adopted by Mr. Holt, although the groups themselves are presented in this report in slightly different form. The groups are as follows:—

I. Unsaleable, or small immature—under 8 ins. in total length.
II. Immature medium-sized—from 8 ins. to 11 ins., both inclusive.
III. Medium-sized mature—from 12 ins. to 14 ins. inclusive.
IV. Large—15 ins. and upwards.

The study of Table F throws important light on various matters of detail, especially on the succession of changes which took place in the distribution of fish during the autumn and early winter of 1901; but the relatively short duration of the hauls made in certain of the months prevents the monthly summaries from possessing an equally representative character. It is accordingly desirable to summarise the results still more closely in quarterly periods. This has been done in the following table, which shows the average catch of plaice per hour for the different size-groups, and also the percentage frequency of the fish of these sizes during the five quarterly periods covered by the investigations.

TABLE V., *showing, for Start Bay, the Average Catch of Plaice per Hour, and the Percentage Frequency for each size, over all stations combined, for each quarterly period.*

				Catch per Hour.					Percentages.			
Season.	hrs.	min.	Total caught.	Total.	0–7″	8–11″	12–14″	15″+	0–7″	8–11″	12–14″	15″+
July, Aug., Sept.,'01	23	10	444	19	2	3	8	6	9	18	44	29
Oct., Nov., Dec. ,,	52	20	1064	20	0·2	3	10	7	1	18	47	34
Jan., Feb. '02	10	45	115	11	1	4	4	2	10	36	32	22
April, May, June ,,	31	55	570	18	1	4	8	5	4	23	45	28
July, August ,,	17	15	403	23	1	11	8	3	3	47	35	15

The investigations began in the summer period, and it will be seen that the total catch of plaice, irrespective of size, increased slightly during the autumn period, fell to a minimum in the winter, and then increased steadily through the following spring and summer, the maximum in the summer season of 1902 being distinctly higher than during the corresponding season of the previous year.

The quarterly average catch of small plaice never exceeded two fish for an hour's fishing. The immature medium-sized fish steadily increased throughout the period of the investigations from an average catch of 3 per hour in the summer of 1901, to a catch of 11 per hour in the summer of 1902. The mature medium-sized fish began in the previous summer with an average abundance of 8 per hour, which increased to a maximum of 10 per hour in the autumn, declining conspicuously to

4 per hour in the winter, and again rising to the same original level of 8 per hour in the spring, which was maintained throughout the summer. The largest fish showed a similar sequence of changes for the first twelve months, but, according to the figures, declined during the last summer season to half their original frequency.

The sequence of changes shown by the mature medium-sized plaice is readily explained by the seasonal migrations of the fish, which are dealt with in a later section of this report. It is there shown that the plaice tend to immigrate into Start Bay from all quarters during the spring and summer months, from the offshore spawning-grounds in the spring, and from the other bays to the northward in summer and autumn. Towards the end of the year they again leave the bay for the offshore spawning-grounds. The figures illustrating the seasonal changes in the abundance of the largest fish would also be explicable in the same way, were it not for the unusual decline shown by the figures for the last summer quarter. If reference, however, be again made to Tables III. and IV., it will be seen, as previously mentioned, that Station III. is represented in the records for the first four quarterly seasons, but is not represented in the last, and it will be remembered that this station is characterised by the large size of its plaice. Station II. also, in which the actual abundance of marketable plaice is greater than in the other stations, is represented far more conspicuously during the summer season of 1901 than during that of the succeeding year. If the hauls on the Skerries Bank (Station III.) be omitted from the records for the first summer quarter, and if the influence of Station I. on the records for the second summer quarter be reduced to the same proportions as prevailed during the first, the catch per hour of the different groups of plaice takes the following dimensions:—

	Catch per Hour.					Percentages.			
Season.	Total.	0-7″	8-11″	12-14″	15″+	0-7″	8-11″	12-14″	15″+
July-Sept., 1901	18	2	4	8	4	13	22	44	21
July-Aug., 1902	28	1	15	9	3	4	53	32	11

It will be seen that there is now no longer any material difference in the evidences of abundance of the largest groups of plaice in this season during the two years; while, on the other hand, the great increase in the abundance of immature medium-sized plaice becomes still more obvious. As will be seen in the case of the other bays, a marked increase in the numbers of this group of plaice in the summer of 1902, as compared with the summer of 1901, was a general feature which characterised each of the bays.

The important question now arises: Which of these years was most typical of the conditions normally prevalent in Start Bay? Was the scarcity of small plaice in 1901 normal or abnormal? Was this marked increase during 1902 an exceptional feature, or merely the prelude of a return to more normal conditions?

There is no available means of answering these questions except by a comparison with the results contained in Mr. Holt's previous report on the Association's work in the bays during 1895 to 1898, from which the following table has been prepared.

TABLE VI., *showing the Catch per Hour and the Percentage Frequency of Plaice of different sizes in Start Bay during* 1895–1897, *based on the records of the "Thistle" and "Busy Bee" (compiled from Mr. Holt's report).*

Season.	Vessel.	hrs.	min.	Total	Catch per Hour.					Percentages.			
					Total	0–7″	8–11″	12–14″	15″+	0–7″	8–11″	12–14″	15
March, '96, '97 .	*Thistle*, 3 hauls *Busy Bee*, 1 haul	9	0	423	47	13	23	8	3	26	50	18	
May, June, '97 .	*Busy Bee*, 4 hauls	8	50	144	16	7	7	1	1	46	40	8	
July, '98 . .	,, 2 hauls	3	45	58	15	4	8	2	1	29	50	14	
Oct., Dec., '95, '96	*Thistle*, 6 hauls	23(ea.)		1011	44	0·1	16	23	5	1	37	52	1

The chief difficulty in a comparison with these records arises from the fact that the previous investigations of the Association were carried out by means of two boats, the smack *Thistle* and the small steam yacht *Busy Bee*, which were of different catching power compared with one another as well as with the *Oithona*. It will be seen that the work in the winter and autumn seasons during the previous investigations was mostly carried out by the *Thistle*, and during the summer by the *Busy Bee*.

It will also be seen that the average catch of the *Busy Bee* in spring and summer was so markedly inferior to the catch of the *Thistle* in autumn and winter that no conclusions can be drawn from the figures as they stand in regard to the seasonal changes which formerly took place in the abundance of plaice in the bay; but at least two methods of comparison with the records of the *Oithona* are open to us, viz. (1) the percentage distribution of plaice of different sizes can be compared with the corresponding figures for the *Oithona's* work, and (2) the average hourly catch of the *Busy Bee* may be assumed to have been *not greater* than that of the *Oithona*, since the *Busy Bee* was a somewhat smaller vessel and carried a smaller trawl.

If we take the latter point first into consideration, we may observe that whereas in the spring and summer seasons the *Busy Bee* made, in Start Bay, an average hourly catch of 16 and 15 plaice respectively, the *Oithona*, during the corresponding seasons, caught 18 plaice per hour in the spring, from 18 to 19 per hour in the summer of 1901, and from 23 to 28 per hour in the summer of 1902. The total catch, as was to be expected, was therefore higher in the case of the *Oithona* than in that of the *Busy Bee*. Nevertheless, on turning to the table again, we see that during the spring quarter the *Busy Bee* caught a far higher average quantity of small plaice per hour than did the *Oithona*, viz. 14 plaice per hour below 12 inches in length, as against only 5 per hour in the case of the *Oithona*. Again, during July the *Busy Bee* caught an average of 12 fish per hour below 12 inches in length, whereas in the summer quarter of 1901 the *Oithona* caught only 6 per hour. The conclusion appears to be that the small plaice below 12 inches in length were abnormally scarce in Start Bay during the summer of 1901; and the records show that this abnormal scarcity continued until the corresponding season of the following year.

We have already seen that in the summer of 1902 the *Oithona* caught a far higher number of immature medium-sized fish than in the corresponding season of the previous year. In Start Bay the average catch of these immature fish was from 13 to 16 per hour. For this bay, therefore, we may conclude that the marked increase in the small plaice during the summer of 1902 was not in itself an abnormal feature, but was rather a sign of the resumption by the bay of its normal characteristics, the scarcity of the small fish during the previous year having been an exceptional phenomenon.

The marking experiments, to be described below, give good ground for believing that the actual increase in numbers of the medium-sized plaice during the summer of 1902 was due to immigration from Teignmouth and Tor bays. There is also no evidence that any material proportion of the plaice of this size in Start Bay were derived by growth from the small stock of small plaice (below 8 ins.) previously in the bay.

The explanation of the scarcity of the small plaice during 1901 and the earlier half of 1902 is dealt with at a later stage (pp. 472 and 474); but it is worthy of note that the phenomena described in the case of the plaice were closely paralleled by changes which took place during the same period in the abundance of small dabs.

TABLE VII., *showing, for Start Bay, the total number of* DABS *measured, and the Catch per Hour and Percentage Frequency of Small and Marketable Fish for each Monthly or Quarterly Period.*

Season.	No. of Hours.		Total caught.	Catch per Hour.			Percentages.	
1901.	hrs.	min.		0-7″	8″+	Total.	0-7″	8″+
July, August	8	55	93	6	5	11	55	45
September	14	15	231	3	13	16	21	79
October	13	5	486	5	32	37	13	87
November	17	5	290	3	14	17	16	84
December	18	10	89	+	5	5	6	94
1902.								
January, February	10	45	77	3	4	7	36	64
April, May, June	25	55	472	13	5	18	74	26
July, August	14	15	1077	66	9	75	88	12
October	1	30	69	45	1	46	97	3
Totals	123	55	2884	13	10	23	56	44

Table VII. shows that in the summer and autumn of 1901 there was a great scarcity of small dabs as compared with the corresponding season of 1902. The difference cannot be attributed to differences in the combination of the stations, since Station III., which alone exhibits a deficiency of dabs, is not represented in the averages for July and August in either year.

If we again use Mr. Holt's figures for 1895–8 as a test, we find that in July the *Busy Bee* made an average catch of 29 dabs per hour, of which 22 were small and 7 marketable. Thus the *Oithona's* figures for 1901 may be taken as indicating an abnormal scarcity of dabs, especially small dabs, in Start Bay; while the figures for the spring and summer of 1902 indicate the gradual resumption by the dabs of at least their former abundance.

As a matter of fact, during the investigations in 1895–8, the dabs in Start Bay outnumbered the plaice in each season of the year; whereas in 1901–2 the reverse was the case until the summer of 1902, when three times as many dabs were taken as plaice.

TABLE VIII., *showing, for Start Bay,* (1) *the total proportion of Dabs to Plaice, and* (2) *the proportion of Large Dabs* (8 *inches and upwards*) *to Large Plaice* (12 *inches and upwards*), *for each quarter during the two sets of investigations. The number of Plaice has been taken in each case as* 100.

	Total Dabs to Plaice.		Large Dabs to Large Plaice.	
	1901–2.	1895–8.	1901–2.	1895–8.
July to September	73	186	68	225
October to December	86	120	91	126
January to March	67	114	79	139
April to June	91	106	32	255
July to September, 1902	311	—	77	—

These facts are shown in the accompanying table, in which the relative abundance of large dabs and plaice is also compared for the two periods. The size limits selected correspond roughly with the size of maturity in the two species. It will be observed that in 1895–8 the mature dabs outnumbered the mature plaice in Start Bay in each season of the year, whereas in 1901–2 the reverse was the case, even during the summer of 1902, when so many small dabs were taken.

It appears permissible to conclude from these data that, whatever the causes which had led to the scarcity of immature intermediate-sized plaice in 1901, the previous abundance of dabs was reduced to a still greater extent; and that both species were recovering from this wave of depression in the course of 1902. The previous scarcity of these fish cannot therefore be attributed to the "fouling" of the ground from lack of trawling, since under such circumstances the dab, as a mud-loving species, would probably have suffered less than the plaice, and the subsequent signs of recovery of both species would receive no explanation.

The results of the *Garland's* experiments in the closed waters of the Scottish bays and firths have given rise to the belief that the prohibition of trawling in inshore waters may protect the dab more efficiently than the plaice, and increase the proportion of the former to the latter. It is therefore of interest to note that this idea receives no support from a comparison of the two series of trawling experiments in Start Bay. The chief feature of these experiments as regards the dab appears to be the liability of this species to fluctuations in numbers, which are more extensive even than in the case of the plaice.

TORBAY.

Dr. Kyle describes the characters of the trawling-grounds and stations as follows :—

"The physical conditions existing in Torbay are widely different from those of Start Bay. The tidal movements of the water are weak at all times, and so are the currents alongshore, except at the south-west corner, where the strong eddy of the Great West Bay makes itself felt as it passes round Berry Head. The direction of the currents is greatly affected by the prevailing winds.

"The comparative lack of tidal movements is reflected in the nature and disposition of the bottom-soil. In the centre of the bay there is nothing but mud, which is continuous from the long stretch of similar soil extending some ten to twelve miles off Berry Head. The mud is continued on the northern aspect right on to the beach at Torquay, where it grades into fine sand. Under the present bed of Torbay lie the remains of an ancient forest, and lumps of peat were occasionally brought up in the trawl. At times, also, fossil bones are obtained on the beach at Torquay, where, as at Brixham, there are famous caves containing fossil remains. On the southern half of the bay, from Paignton to Berry Head, the beach is quite free from mud, and various grades of sand extend from the shore for some distance, varying from a few yards off Fishcombe Rocks to a quarter of a mile off Goodrington Sands and the back of the breakwater at Brixham. Off the angle of the bay formed by Ellbury Cove lies a small patch of rocks, locally known as the 'Rough,' and it is close to this that the finest and largest fish are caught. There are several detached rocks on the Torquay side, extending from Torquay out to the Orestone, and various ('innumerable,' according to the fishermen) anchors scattered about the bay. The trawlable area is about seven square miles.

"As may be gathered from the preceding account of the physical conditions, Torbay is very liable to become 'foul,' especially during the summer. The Brixham and Torquay fishermen will have it that this is partly, if not entirely, due to the absence of trawling, and though it is merely a matter of opinion, it is possible that they have a certain amount of right in their contention. Even a slight scraping of the bottom in, say, a stagnant pool has some influence on the distribution and circulation of muddy material. It is difficult, on the other hand, for the fishermen to recognise that the 'foulness' of the bay has not been caused by the Devon Committee's by-laws, but is due to its geographical situation and the weakness of its tides and currents. In the summer time, indeed, it is a veritable sink for a great part of the débris of the great West Bay, and it has sufficient decomposing material in its own composition to serve three or four bays.

"The trawling stations in Torbay are four in number, as follows:—

"**Station IV.** From Paignton Head to Torquay Harbour, half a mile from the shore. The bottom-soil is fine sand and mud, and the depth 3 to 4 fathoms. [Haul No. 4 on September 11th extended eastwards beyond Brixham breakwater.—W. G.]

"**Station IVa.** Round the 'Rough' from Paignton Head to off Ellbury, thence outward towards Brixham breakwater. The bottom soil is at first sand, later mud, and the depth from 3 to 4 fathoms.

"**Station V.** Centre of the bay, on line Brixham breakwater to Ilsham Valley, between Torquay and Hope's Nose. The bottom-soil is mud, and the depth 6 fathoms.

"**Station VI.** On line Berry Head to Orestone. The bottom soil is again mud, and the depth 8 to 10 fathoms. [This station lies just outside the limit fixed by the Devon Sea Fisheries Committee.—W. G.]

"The stations in Torbay differ less from one another than those of Start Bay, but the proportions of the various species of fish are, on the whole, similar. The dabs and plaice are the most numerous, whilst the remaining species taken together are fewer in numbers than the plaice by itself."

The following table represents the results of the *Oithona's* catches in Torbay during the year reduced to the average catch per hour for each of the four stations:—

TABLE IX.

Species.	Station IV. 9 hrs. 55 min.		Station IVa. 11 hrs. 30 min.		Station V. 10 hrs. 35 min.		Station VI. 7 hrs. 25 min.		Totals excluding Station VI. 32 hrs.		Totals including Station VI. 39 hrs. 25 min.		
	Small.	Marketable.	Small.	Marketable.	Small.	Marketable.	Small.	Marketable.	Small.	Marketable.	Small.	Marketable.	Tota
Plaice	36	29	11	18	22	21	3	6	23	22	19	19	38
Dabs	82	4	19	1	103	8	7	10	66	4	55	6	61
Sole	–	1	–	1	+	+	–	+	+	1	+	1	1
Brill	+	–	+	+	+	–	–	+	+	+	+	+	+
Grey Gurnard	4	+	1	+	11	+	3	+	5	+	4	+	4
Whiting	1	1	–	–	12	3	6	–	4	1	4	1	5
Thornback	9	–	2	–	6	+	23	3	5	+	8	1	9
Homelyn	–	–	–	–	–	–	+	–	–	–	+	–	+
Blonde	+	–	–	–	–	–	–	–	+	–	+	–	+

The table illustrates the following extract from Dr. Kyle's report:—

"The accompanying table shows that there are only two species in Torbay—the **plaice** and the **dabs**—which are worthy of any attention, amongst trawled fish that is to say, for the fishermen, especially of Torquay, earn a good living from the mackerel and other roving round fish which enter the bay. With these, however, we are not concerned; they are seldom obtained by the trawl, and to the trawlers as trawlers they are of no value. Amongst the trawled fish the large proportion of **thornback rays** demands a word of explanation. They are almost entirely small fish under 12 inches from wing to wing, and are most probably migrants from the neighbouring Teignmouth Bay, where their spawning ground seems to be.

* * * * * *

"The **dabs** are even more numerous in Torbay than in Start Bay, and their distribution over muddy ground is more clearly shown. On Station IVA., near the Rough, the proportion of dabs is less than that of the plaice, and the bottom-soil here, it will be remembered, is of a sandy nature. Over the rest of the bay, where the soil is muddy, the proportion of dabs is greatly in excess of the plaice.

"It appears from the table that the proportion of small dabs under 8 inches greatly exceeds that of the larger over this size and at all times of the year. This is not to be wondered at when it is remembered that the dab is mature on the average below 8 inches.

"**Soles** are by no means numerous, but the great majority were over 8 inches, only one being captured under that size. **Flounders** are more numerous, and were taken at all seasons of the year. Useless species, as **solenette, dragonet, bib,** and **scaldback,** are very common, but the useful forms other than those mentioned are few in numbers and mostly small."

It is, however, necessary to add to Dr. Kyle's remarks that Station VI., strictly speaking, lies outside the trawling limit of the bay, as fixed by the Sea Fisheries Committee.

The station, owing to its greater depth, naturally exhibits a preponderance of large fish over small, in the case of plaice and dabs. The actual catch per hour of the larger plaice is less than on the other stations, and of the larger dabs somewhat greater. The station exhibits a higher catch of thornbacks than any other in the bay.

As will be seen from a comparison of the parallel columns of "totals" excluding and including this station, the inclusion of the station in the summaries has the effect of slightly depressing the average catch of plaice, both small and marketable—the former slightly more so than the latter. It is obvious, also, that its inclusion will have a tendency to slightly increase the percentage of large fish in the general averages at the expense of the small.

The following table shows the actual amount of fishing carried out by the *Oithona* on the various stations at different seasons of the year.

TABLE X., *showing the Amount of Trawling over each station in Torbay, for each quarterly period of the year.*

Season.	Station IV. No. of hours. hrs.	min.	Station IVA. No. of hours. hrs.	min.	Station V. No. of hours. hrs.	min.	Station VI. No. of hours. hrs.	min.
July, Aug., Sept., 1901	3	10	1	0	2	5	2	40
Oct., Nov., Dec. ,,	3	15	5	20	4	0	1	0
Jan., 1902 . . .	1	0	—		—		0	45
April, May, 1902 .	1	0	2	10	1	15	1	0
July, Sept. ,, . .	1	30	3	0	3	15	2	0
Totals	9	55	11	30	10	35	7	25

SEASONAL CHANGES.

The following table represents a quarterly summary of the average hourly catches of plaice by the *Oithona* in Torbay, distinguishing the various size-groups.

TABLE XI., *showing, for Torbay, the Average Catch of Plaice per Hour, and the Percentage Frequency for each size, for each quarter of the year, over all the stations combined.*

Season.			Total	Catch per Hour.					Percentages.			
	hrs.	min.	caught.	Total.	0-7″	8-11″	12-14″	15″+	0-7″	8-11″	12-14″	15″+
July, Aug., Sept.,'01	8	55	408	46	22	13	9	2	47	27	20	6
Oct., Nov., Dec. ,,	13	35	507	37	21	7	6	3	57	19	15	9
Jan., 1902 . .	1	45	48	27	21	2	3	1	77	8	11	4
April, May, 1902 .	5	25	133	25	17	4	3	1	66	16	13	5
July, Sept. ,, .	9	45	404	41	14	22	3	2	35	53	7	5

The total catch, irrespective of size, is seen to have steadily fallen from a maximum of 46 per hour in the summer of 1901 to a minimum catch of 25 per hour in the spring of 1902, after which the catch rose to 41 per hour in the following summer quarter. This second summer maximum is less than that which obtained in the previous year. The small fish, from 0 to 7 inches in length, are seen to have steadily diminished in abundance from 22 per hour in the summer of 1901 to 14 per hour in the summer of the following year. It is remarkable that the figures should show no sign during the last quarter of the increase in numbers which is usual at this season.

It will be seen, however, upon reference to Table X., which shows the relative amount of fishing on different stations for each season, that during the summer of 1901, as compared with the summer of 1902, the *Oithona* trawled twice as long over Station IV., where the small fish are most abundant, and only one-third as long over Station IVA., where they are much less abundant. If the influence of Stations IV., IVA., and V. for 1901 be reduced to the same relative proportions as prevailed in 1902, omitting Station VI. in each case, the catch per hour during the two seasons becomes altered as follows :—

	Catch per Hour.					Percentages.			
Season.	Total.	0–7″	8–11″	12–14″	15″+	0–7″	8–11″	12–14″	15″+
July–Sept., 1901	45	15	14	11	5	33	32	24	11
July–Sept., 1902	51	18	27	3	3	35	53	7	5

Now that the two seasonal averages have been made comparable, it will be observed that the discrepancies in the general averages were largely attributable to the disproportionate combination of hauls over different grounds in the two seasons. Instead of a relative fall in the total catch of fish in 1902 as compared with the previous year, the maximum for 1902 is now seen to be somewhat in excess of that for 1901, and the small fish below 8 inches in length are seen in reality to have been not less numerous, but slightly more abundant in the later than the earlier year. The figures for the other size-groups are not so seriously affected, but the hourly catch of large fish above 15 inches is slightly raised in both years by the omission of Station VI., which, strictly speaking, lies outside the limits of the bay. It will be further noticed that the marked increase in the number of immature medium-sized plaice, which the general average in Table XI. revealed for the summer season of 1902, is confirmed.

With the exception of the season just referred to, it will be noticed that the smallest plaice were more abundant than any of the other size-groups at each season of the year, in spite of the depressing effect of a somewhat high representation of Stations IVA. and VI. in the general averages. Indeed, for the greater part of the year the fish below 8 inches in length were actually more numerous than the plaice of all other sizes taken together. This result contrasts markedly with the condition previously shown to have obtained in Start Bay, where the predominant group of plaice was, for the most part, that from 12 to 14 inches. In other words, the mature medium-sized plaice were the most abundant in Start Bay, while the small unsaleable fish took the lead in Torbay.

Nevertheless, the actual abundance of mature medium-sized plaice in Torbay during the latter half of 1901 was scarcely less than in Start Bay. Their greater scarcity in the summer of 1902 is an isolated feature which it is not easy to explain with certainty. The results of the marking experiments in the spring of 1902 demonstrate that the plaice in the mouth of Torbay showed a far stronger tendency to migrate southwards into Start Bay than into Torbay itself during the summer season; so that the trawling statistics accord with the migration experiments on this point. Why the larger fish should have displayed this disinclination to enter the bay remains unexplained. It is not improbable that variations in the "foulness" of the ground in Torbay may be largely responsible for such fluctuations in the numbers of summer immigrants, as well as for emigrations of the normal inhabitants of the bay, as suggested below by Dr. Kyle in the case of Teignmouth Bay.

We may now compare these results with the distribution of the different sizes of plaice in Torbay, as recorded by Mr. Holt for 1895–8.

TABLE XII., *showing the Catch per Hour and the Percentage Frequency of Plaice of different sizes in Torbay during* 1895–8, *based on the records of the "Thistle" and "Busy Bee"* (*compiled from Mr. Holt's report*).

Season.	Vessel.	hrs.	min.	Total caught.	Catch per Hour. Total.	0–7″	8–11″	12–14″	15″+	Percentages. 0–7″	8–11″	12–14″
Jan., March, '97	*Thistle*, 3 hauls	4	50	420	87	23	35	26	3	26	40	30
June, '97 . .	*Busy Bee*, 2 hauls	2	55	410	141	90	27	20	4	64	19	14
July, '98 . .	,, ,,	2	25	110	45	11	29	4	1	24	63	9
November, '95 .	*Thistle*, 2 hauls	3	20	100	30	1	15	13	1	4	50	42

Bearing in mind the reservations previously expressed with regard to the comparability of these records (p. 456), it is nevertheless apparent that in July, 1898, the *Busy Bee*, in spite of its somewhat smaller catching power, caught a larger average number of plaice from 8 to 11 inches than did the *Oithona* in the summer season of either 1901 or 1902, and that the higher catch of the *Oithona* in 1902 more closely approached the *Busy Bee's* record than did the smaller catch of 1901. We may therefore conclude that in Torbay, as in Start Bay, the numbers of plaice of this size were abnormally low in 1901, but were increasing to more normal proportions in the course of 1902. The June records of the *Busy Bee* in 1897 suggest the further point that the smallest plaice (especially the 5-inch fish) were more abundant in that year than subsequently. As these fish, after one year's growth, would form the greater part of the 8-to-11-inch group in the succeeding year (see p. 489), it appears to be in the highest degree probable that the observed abundance of the 8-to-11-inch plaice in July, 1898, is traceable to the corresponding abundance of the smallest plaice in the preceding year. In a similar manner the increased abundance of the larger immature plaice in the summer of 1902 was preceded, according to the *Oithona's* records (Tables XI. and D), by a high average catch of the smallest fish (4 and 5 inches) throughout the preceding autumn and winter, an average much higher, it will be noted, than the *Busy Bee's* catches in July and November, and almost as high as the *Thistle's* catch in January to March.

Upon a consideration of all the data, it thus appears fairly certain that in Torbay the observed fluctuations in the numbers of the 8-to-11-inch plaice during recent years are attributable to corresponding fluctuations in the abundance of the still smaller fish in previous years.

Turning now to Dabs, it will be seen from the following table that, as in Start Bay, there was a considerable increase in the abundance of small dabs in the summer of 1902 as compared with 1901—a result which is not attributable to any marked inequality in the combination of the stations.

Table XIII., *showing, for Torbay, the total number of Dabs measured, and the Catch per Hour and Percentage Frequency of Small and Marketable Fish for each quarterly period.*

Season.	No. of Hours.		Total caught.	Catch per Hour.			Percentages.	
1901.	hrs.	min.		0-7″	8″+	Total.	0-7″	8″+
July, August, Sept.	8	55	641	62	10	72	87	13
October, Nov., Dec.	13	35	511	33	5	38	87	13
1902.								
January	1	45	10	6	—	6	100	—
April, May	5	25	138	22	3	25	87	13
July, September	9	45	1096	107	5	112	95	5
Totals	39	25	2396	55	6	61	91	9

In this case Mr. Holt's records show that the catch of dabs in the summer of 1901 was slightly less, in the case of small dabs, than the average catch of the *Busy Bee* for July, 1898, viz. 66 small, 4 large; total, 70. In June of 1897 the *Busy Bee* caught nearly twice as many dabs per hour as did the *Oithona* in the spring of 1902, the numbers being 38 small, 13 large; total, 51. There was, therefore, to some extent, a deficiency of dabs in 1901 and the first half of 1902, as compared with the previous period, 1895–8; but an increase in the summer of 1902, which caused the ultimate numbers of small dabs to attain a higher maximum than had previously come under observation.

As regards the relative numbers of dabs and plaice, there is no such striking contrast between the two series of investigations as was noticeable in the case of Start Bay. The proportion of mature dabs to mature plaice appears, in general, to have been slightly higher in 1901–2 than in 1895–8, especially during the summer of 1902, when, for the first time, the dabs above 7 inches outnumbered the plaice above 11 inches.

TABLE XIV., *showing, for Torbay,* (1) *the total proportion of Dabs to Plaice, and* (2) *the proportion of Large Dabs* (8 *inches and upwards*) *to Large Plaice* (12 *inches and upwards*) *in each quarter during the two sets of investigations* (*Plaice* = 100).

	Total Dabs to Plaice.		Large Dabs to Large Plaice.	
	1901–2.	1895–8.	1901–2.	1895–8.
July to September	157	152	82	64
October to December	101	46	54	56
January to March	21	26	—	11
April to June	104	36	75	54
July to September, 1902	271	—	102	—

With one insignificant exception the total proportion of dabs to plaice was higher in each quarter of 1901–2 than during the previous period, the excess being particularly marked during the spring and summer of 1902. On the whole, therefore, the number of dabs does not appear to have diminished in Torbay during the recent fluctuations to anything like the extent which was manifest in Start Bay, or even to the same degree as the plaice—a difference which is possibly attributable to the muddy character of the bottom, which renders Torbay the chief headquarters of small dabs in the district.

TEIGNMOUTH BAY.

The following account of the physical conditions and trawling stations has been drawn up by Dr. Kyle:—

"With regard to the physical conditions, this bay is intermediate between Torbay and Start Bay. There is comparatively little tidal movement in the centre of the bay, with the result that we find there a long belt of mud extending from Hope's Nose to off Exmouth. In this respect it resembles Torbay. There are moderate currents alongshore, however, which in the northern portion of the bay seem in the main to tend northward towards Exmouth, but in the southern half towards Hope's Nose. We find, consequently, that there is a long stretch of sand, mostly coarse, extending from five fathoms on to the beach and from Hope's Nose to the Pole Sands at Exmouth. The best trawling-ground is along this belt of sand, and in the fall of the year it is quite as rich as any part of Start Bay in large plaice and soles. Along the line from Hope's Nose to Straight Point (the Rubicon for trawlers) lies the beginning of the rough ground called the Ledge. At this point it is not yet untrawlable, but the large quantity of oysters and stones make it somewhat dangerous for the net.

"This bay differs from the others in that two rivers, the Teign and the Exe, flow into it. These are of importance because the young plaice of one to three years find them a harbour of refuge—from the trawlers only, for the seiners and cormorants exact toll.

"For the purpose of the experiments the bay was divided as follows:—

"**Station VII.** Off Babbacombe Bay to the Ness, near Teignmouth. The depth is 4–5 fathoms, and the bottom-soil sand. [Haul No. 4 was made in somewhat deeper water, but the particulars are doubtful.—W. G.]

"**Station VIII.** A continuation of the preceding to the Fairway Buoy off Exmouth. The depth and bottom-soil are still the same. Very few hauls were made over the entire length of this station. As a rule it was divided into two portions, one from off Teignmouth to off the Clerk Rock, the other along the Pole Sands at Exmouth, but as the composition of the ground and the fauna are practically identical the records are taken together.

"**Station IX.** On the line, Orestone to the Fairway Buoy off Exmouth, from near the Orestone to off Teignmouth. The depth is 11–12 fathoms, and the bottom-soil stones, large shells, but mostly mud. One haul [No. 26] was made from off Teignmouth towards the Fairway Buoy, but it is also included under Station IX. [This station lies just outside the limits fixed by the Devon Committee.—W. G.]

"The differences between these stations are so strongly marked as a rule that one can at once distinguish them by the catches. Station VII. lies in the southern corner of the bay, and is sheltered from the prevalent winds. Here we find a very large proportion of small fish, especially plaice. Station VIII., on the northern half of the bay, is very much exposed to the southerly and south-easterly gales, and the sand which composes its bottom-soil is in constant movement. Small plaice are consequently less abundant, and dabs are comparatively few. A further consequence of the variable nature of the physical conditions is that the catches vary greatly both as regards quality and quantity. The sole and painted ray (*R. microcellata*) are good examples of this. On one occasion, 13th September, 1901, nineteen large painted rays were obtained in one haul. On all other occasions it was almost entirely absent. Again, a considerable number of soles was twice obtained there in November, 1901, and September, 1902, the total number then caught making more than half of the soles obtained in Teignmouth Bay for the whole period. At other times, again, soles seem entirely absent from this region. Plaice and other species show the same fluctuation, and as already mentioned, all forms are more abundant in the fall of the year than at other times.

"Station IX. is readily distinguished by the greater variety of species, especially those useless for food, and the invertebrate fauna. The dominant species is the thornback ray. From the accompanying tables it might appear as if the plaice were the most abundant, but an examination of the tables at the end shows that more than two-thirds (116) of the total (169) were obtained in one haul during July, 1902. Disregarding this haul as exceptional, probably due to the exceptional physical conditions during 1902 to be presently referred to, all the remaining hauls show that coarse fish, thornbacks, buffoons, and dogfish are the distinguishing features of Station IX. The invertebrate fauna is also peculiar, cuttle-fish, oysters, Turritella, Trochus, Natica, Buccinum, hermit-crabs, Porcellana, swimming-crabs (especially *P. puber*), with various species of sea-anemones (especially *Actinoloba*), and hydroids being of exceptional abundance. The relation of the fish fauna to the invertebrates was not determined, but it may be gathered from what has been said that Teignmouth Bay offers a rich field for future research.

"Teignmouth Bay, like Torbay, is very liable to become 'foul' during the spring and summer, on account of the large quantities of drift-weed which the eddy of the Great West Bay carries down. The difficulties of trawling are thereby greatly increased, and the summer hauls are not truly representative of the fish of the bay. Station VII. is perhaps the worst in this respect, and it is probable that its normal inhabitants migrate outwards towards Station IX., whilst the seaweed 'plague' persists. This may account for the unusual number of plaice and dabs caught on the latter station in July, 1902.

"Holt has also remarked upon the incursion of seaweed into Teignmouth Bay during the summer."

The general characteristics of the stations may be gathered from the accompanying table, which has been prepared on the same lines as the corresponding ones for Start Bay and Torbay. The large proportion of small plaice usually caught in Station VII. shows that in any seasonal combination of the records of the different stations the results will not be strictly comparable unless due attention is paid to their proportional representation.

TABLE XV., *showing the Average Catch per Hour for the entire period on the various stations of Teignmouth Bay.*

Species.	Station VII.				Station VIII.				Station IX. 9 hrs.		Totals excluding Station IX.				Totals including Station IX.				
	hrs.	min.	Small.	Marketable.	hrs.	min.	Small.	Marketable.	Small.	Marketable.	hrs	min.	Small.	Marketable.	hrs.	min.	Small.	Marketable.	Tot
Plaice . .	21	50	41	21	20	20	10	11	9	10	42	10	26	16	51	10	23	15	3
Dabs . .	,,	,,	16	5	,,	,,	2	2	8	1	,,	,,	10	4	,,	,,	9	4	1
Sole . .	,,	,,	+	1	,,	,,	+	4	+	2	,,	,,	+	2	,,	,,	+	2	
Brill . .	,,	,,	+	–	,,	,,	+	+	+	+	,,	,,	+	+	,,	,,	1	+	
Grey Gurnard	,,	,,	3	–	,,	,,	+	–	7	+	,,	,,	2	+	,,	,,	3	+	
Whiting .	,,	,,	5	2	,,	,,	+	4	+	1	,,	,,	3	3	,,	,,	3	2	
Thornback .	19	35	12	3	15	35	7	9	9	8	35	10	10	6	44	10	10	6	1
Homelyn .	,,	,,	+	–	20	20	+	+	1	1	39	55	+	+	48	55	+	+	
Blonde .	21	50	+	–	15	35	+	1	+	–	37	25	+	+	46	25	+	+	

In the following table the seasonal duration of the trawling on each station is indicated.

TABLE XVI., *showing the Amount of Trawling over each station in Teignmouth Bay for each quarterly period.*

Season.	Station VII. hrs.	Station VII. min.		Station VIII. hrs.	Station VIII. min.		Station IX. hrs.	Station IX. min.
August, September . .	4	0	...	4	25	...	2	0
October, November, December .	9	35	...	6	15	...	—	—
January . . .	1	30	...	0	45	...	—	—
April, May . . .	5	15	...	4	45	...	4	30
July, September . . .	1	30	...	4	10	...	2	30
Totals .	21	50	...	20	20	...	9	0

It will be observed that while Stations VII. and VIII. were investigated for fairly similar periods in the summer of 1901 and spring of 1902, Station VII. monopolised two-thirds of the time in the autumn of 1901, and only one-fourth of the total time allotted to the stations in the summer of 1902. Station IX. does not appear at all in the records for the autumn and winter, and received relatively more attention in the summer of 1902 than in the corresponding season of the previous year.

The following table shows the general averages for the five seasons:—

TABLE XVII., *showing, for Teignmouth Bay, the Average Catch of Plaice per Hour, and the Percentage Frequency of each size, for each quarter of the year over all the stations combined.*

Season.	hrs.	min.	Total caught.	Catch per Hour. Total.	Catch per Hour. 0–7″	Catch per Hour. 8–11″	Catch per Hour. 12–14″	Catch per Hour. 15″+	Percentages. 0–7″	Percentages. 8–11″	Percentages. 12–14″	Percentages. 15″+
Aug., Sept., 1901	10	25	329	32	14	7	6	5	43	22	19	16
Oct., Nov., Dec. ,,	15	50	969	61	39	11	7	4	65	18	11	6
January, 1902	2	15	89	40	35	1	2	2	88	3	5	4
April, May ,,	14	30	292	20*	13	3	2	2	65	14	11	10
July, Sept. ,,	8	10	298	36	19	12	3	2	54	34	8	4

In the case of Teignmouth Bay it is not possible to draw a comparison between the *Oithona's* records and those of Mr. Holt as regards the abundance of fish in the summer quarter, since the latter was not represented during the previous investigations. It is obvious, however, that Teignmouth Bay is characterised, like Torbay, by the presence of a large stationary population of plaice of the smallest size which, with one exception, form the majority of the total catch in each season of the year. It is also clear that the numbers of immature medium-sized plaice increased considerably in the summer of 1902 as compared with 1901—a feature which we have already seen was characteristic of each of the other bays. The influence of the winter emigrations from the bay is clearly shown for all the groups of plaice of 8 inches and upwards.

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* The figures for the total catch per hour, and catch per hour of small plaice, during the spring quarter, are unduly depressed by the exceptionally large amount of trawling which took place over Station IX. If Station IX. be omitted, as in the two quarters preceding it, the total catch per hour is raised to 25, and the other figures become 19, 2, 2, 2 respectively. The percentage of small plaice also becomes raised to 76 per cent.

These features are not dependent on the disproportionate combinations of the stations in the different seasons, or on the inclusion of Station IX. (which does not materially influence the figures for any of the size-groups except the smallest). The influence of Station VII. on the averages for the first summer season was much greater than for the second, but its reduction to the same proportions merely reduces the total average catch for the first season from 32 to 28, the figures for the four size-groups becoming respectively 12, 6, 5, 5.

For the study of minuter points than those mentioned above, however, it is impossible to reduce the quarterly figures to a comparable basis of a reliable character owing to the small amount of trawling on Station VII. in the second summer, and to the irregular character of the midsummer records caused by the presence of drift-weed (cf. Tables C, D, hauls 2 and 29 on Station IX.). The most comparable records in the two years are those for September, the hauls for which month are limited to the inshore Stations VII. and VIII. It would appear from Table E that while the number of 8-to-11-inch plaice was twice as great in September, 1902, as in the same month of the previous year, the numbers of the smallest fish were about the same. These, however, as appears from the detailed Table D, were mostly 6- and 7-inch fish in the second year, with little admixture of 4-to-5-inch fish, whereas in the first year there was a considerable number of the latter. It would thus appear that in 1901 there was a greater abundance of the smallest plaice than in 1902, a view confirmed by the detailed records of the catches in July and August. As these smallest plaice would, a year later, become 8-inch fish, and as fish of this size preponderate in the 8-to-11-inch group, it is probable that the marked increase in the numbers of the 8-to-11-inch group during 1902 should be attributed to the abundance of 4- and 5-inch fish in the previous year. This conclusion has already been drawn in explanation of the same phenomenon in Torbay.

The increase of Dabs during the summer of 1902, which has already been noticed in the case of Start Bay and Torbay, is equally conspicuous in the records for Teignmouth Bay, as the following table reveals:—

TABLE XVIII., *showing, for Teignmouth Bay, the total number of Dabs measured, and the Average Catch per Hour and Percentage Frequency of Small and Marketable Fish for each quarterly period.*

Season.	No. of Hours. hrs.	min.	Total caught.	Catch per Hour. 0–7″	8″+	Total.	Percentages. 0–7″	8″+
August, Sept., 1901	10	25	127	9	3	12	71	29
Oct., Nov., Dec. ,,	15	50	265	9	7	16	57	43
January 1902	2	15	4	2	–	2	100	–
April, May ,,	14	30	22	1	1	2	50	50
July, September ,,	8	10	242	27	2	29	92	8
Totals . .	51	10	660	9	4	13	73	27

In the following table the relative numbers of dabs and plaice caught during the two periods of investigation are displayed according to the plan adopted for the other bays. It will be observed that during each period the total number of dabs was generally less than half the total number of plaice at each season of the year, the only important exception being in the summer quarter of 1902, when, as in the other bays, there was a great relative increase in the number of dabs. This increase did not, however, lead to the plaice being actually outnumbered, as was the case in Start Bay. The fact that in Teignmouth Bay the plaice always maintain their superiority in point of numbers over the dabs is doubtless due to the perennial supply of young plaice from the estuaries which open into this bay, whereas the young dabs do not derive the same advantage from the proximity of these estuaries, owing to their less restricted habits. It will also be observed that during 1901–2 the proportion of dabs to plaice was distinctly lower than during the previous period 1895–8 at each season of the year for which there are corresponding records. This contrast holds whether the totals or the large fish alone are taken into consideration.

TABLE XIX., *showing, for Teignmouth Bay,* (1) *the total proportion of Dabs to Plaice, and* (2) *the proportion of Large Dabs* (8 *inches and upwards*) *to Large Plaice* (12 *inches and upwards*), *for each quarter during the two series of investigations* (*Plaice* = 100).

	Total Dabs to Plaice. 1901–2.	1895–8.	Large Dabs to Large Plaice. 1901–2.	1895–8.
July to September . .	39	(?)	32	(?)
October to December .	27	51	67	165
January to March . .	5	29	None	27
April to June . .	8	22	18	43
July to September, 1902 .	81	—	51	—

The Causes of the Observed Fluctuations.

It has been shown in the preceding pages that during the year 1901–2 there was a remarkable scarcity of immature medium-sized plaice (8 to 11 inches) in all three bays, as compared with the period 1895–8, previously investigated. This scarcity was limited to the year 1901 and the first half of 1902, and was followed in the summer of 1902 by an increased abundance of plaice of this size, as well as of small dabs.

We have seen that there are distinct indications in the trawling records that these fluctuations were generally preceded in the previous year by corresponding fluctuations in the abundance of fish one year younger. The available evidence does not amount to a conclusive demonstration; but the indications of this correlation are sufficiently definite to form the basis of a working hypothesis. The existence of such a correlation would lead at once to the conclusion that the causes of the observed fluctuations were quite independent of the restrictions placed upon trawling in the bays, and were to be sought in the conditions which naturally influence the reproduction of the fish from year to year. The fluctuations in the numbers of small flat-fish in the bays are therefore probably attributable to changes in the physical conditions in previous years, which caused sometimes a larger and sometimes a smaller proportion of the floating eggs and larvæ to set into the bays and undergo a successful metamorphosis there.

These remarks apply to Teignmouth Bay and Torbay, but only indirectly to Start Bay, which apparently possesses no natural rearing-ground (or "nursery") for the smallest plaice, and seems to derive the bulk of its population of medium-sized plaice by migration from the other bays to the northward.

Of the various physical factors capable of producing the changes above mentioned, none would appear to possess so great an importance as the direction of the winds during the spawning season of the fish, owing to their dominant influence upon the set of the currents.* The problem deserves fuller treatment than it is possible to give to it on the present occasion, but an analysis of the meteorological records of the Rousdon observatory (near Lyme Regis) for the years 1891 to 1901 lends distinct support to the view expressed.

For the region under discussion we may assume that south-easterly winds (*i.e.* E., S.E., and S.) would be favourable, and north-westerly winds (*i.e.* N., N.W., and W.) would be unfavourable,—the spawning season of the plaice in this district being January, February, and March.

(1) We have already seen that small plaice of 4 and 5 inches were

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* Cf. Garstang, "Report on the Surface Drift of the English Channel and Neighbouring Seas during 1897," *Journ. M. B. A.*, vol. v., pp. 199–231. (Other literature cited.)

unusually abundant in June, 1897, according to Mr. Holt's records. These would be two-year-old fish,* hatched in the early part of 1895. During the first three months of that year the percentage of unfavourable winds was less than normal (49 per cent.), and of favourable winds above the normal frequency (21 per cent.), the range of variation throughout the decade being from 46 per cent. to 60 per cent. for "unfavourable" winds, and from 13 per cent. to 26 per cent. for "favourable" winds.

(2) Similarly the abundance of two-year-old fish in 1901 as shown by the *Oithona's* records may be attributed to the prevalence of southeasterly winds (E. to S.W. through S.) in February, 1899.

(3) The most unfavourable year in the decade was 1898, when the percentage of "favourable" winds was at its minimum (13 per cent.), and that of "unfavourable" winds at its maximum (60 per cent.). The plaice hatched in that year would be three and a half years old in the summer of 1901, *i.e.* for the most part between 8 and 9 inches in length. It can scarcely be without significance that the scarcity of plaice of this size in the summer of 1901 is one of the most striking features of the *Oithona's* records.

Mention may here be made of the fact that towards the end of January and in the early part of February, 1898, three dozen of the Association's drift-bottles were put overboard at various points between 14 and 20 miles S.E. and E.S.E. of Berry Head from the Brixham smack *Sunbeam*, through the instrumentality of Mr. W. J. Sanders, and every one of the bottles recovered was picked up on the French coast, with the exception of one bottle recovered by a Brixham smack two days after it had been thrown overboard. This bottle was found 6 miles S.E. of its initial position. If, as seems probable, an exceptionally large proportion of the eggs of the plaice drifted out to sea in that year in the same direction, it is scarcely surprising to find that the trawling investigations should subsequently reveal a phenomenal scarcity on the Brixham grounds of plaice derivable from that spawning season. The fact at any rate confirms the accuracy of the hypothesis from which we started.

SUMMARY OF THE TRAWLING RECORDS.

The following points appear to be established by the preceding analysis of the trawling records for the three bays:—

1. The population of flat-fish, especially of plaice and dabs, in the three bays is subject to considerable fluctuations, both from season to season and from one year to another.

2. The *seasonal* fluctuations are more pronounced in the case of the

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* Fulton, "Rate of Growth of Sea Fishes," *Twentieth Report Scottish Fishery Board*, 1902, pp. 337 to 360.

larger fish of these two species than of the smaller fish. It will be shown below that, for the plaice, the explanation of this difference is to be found in the peculiarities of their migrations.

3. In Start Bay the seasonal fluctuations of plaice are only appreciable in the case of mature fish. Practically the whole of the plaice below 12 inches in length appear to reside in the bay throughout the year, and do not usually emigrate on the approach of winter until they have attained the size mentioned.

In Torbay and Teignmouth Bay the seasonal fluctuations of plaice extend also to the immature medium-sized fish. (Experiments with marked fish, especially in Teignmouth Bay, show that the plaice in these bays emigrate at a smaller size than in the case of Start Bay.)

4. The *annual* fluctuations in the abundance of plaice are traceable to changes which take place from year to year in the numbers of the smallest fish present in the bays. A decrease in the number of the smallest group one year is followed by a decrease in the number of fish one year older in the following year. An increase in the smallest is similarly followed by an increase in the numbers of larger fish in the years immediately following.

5. The observed changes cannot be explained as due to the prohibition of trawling in the bays, since fluctuations in both directions have taken place during the period of closure.

6. The facts are most fully explained on the hypothesis that changes from year to year in the physical conditions which influence the distribution of floating eggs and larvæ cause sometimes a larger and sometimes a smaller proportion of the eggs and fry to set into the bays and undergo a successful metamorphosis on the rearing-grounds there.

The chief agency capable of inducing these changes appears to be the direction of the winds during the spawning season. The records tend to show that a prevalence of south-easterly winds during the spawning season of the plaice in any year in the South Devon district is followed by the survival of a greater percentage of the fry of that year, and an unusual amount of north-westerly winds by an increased mortality.

7. The closure of the bays to trawlers does not appear to have appreciably favoured the dab at the expense of the plaice, since, during the year ending June, 1902, the proportion of dabs to plaice was less in Start Bay and Teignmouth Bay than during the previous investigations from 1895–98, and was higher only in the case of Torbay, where conditions peculiarly favourable to the dab are found. In the summer of 1902 an unprecedented increase in the number of small dabs was shown by the trawling records for each bay, and exceeded a simultaneous increase in the number of small plaice.

Changes of this kind may possibly, after a series of years, bring about a nett result to the advantage of the dab; but, as the spawning season of the dab does not precisely coincide with that of the plaice, a detailed examination of the fluctuations of the dab in relation to the physical conditions prevailing during the various spawning seasons is necessary before any such difference can be attributed with confidence to the differential effects of protection on dabs and plaice respectively. The only point established by the investigations as regards the dab is that this species is subject to even greater fluctuations in abundance than the plaice.

8. In spite of the seasonal and annual fluctuations to which the numbers of flat-fish in the bays are subject, it is clear that there is an essential difference between Start Bay and the other bays to the northward as regards the normal proportions of large and small fish.

The following table shows the extent of the seasonal fluctuations in the percentage of plaice of different sizes for each bay, as shown by the quarterly averages of the *Oithona's* records.

	Length of fish.	Start Bay. Per cent.	Torbay. Per cent.	Teignmouth Bay. Per cent.
Immature	0-7 ins.	1–13	33–77	43–88
	8–11 „	18–53	8–53	3–34
Mature	12–14 „	32–47	7–24	5–19
	15 ins. and above	11–34	5–11	4–16

Start Bay showed a preponderance of mature plaice at all seasons of the year, and an insignificant proportion of small plaice below 8 inches in length (never more than one-eighth of the total number present). On the other hand, Torbay and Teignmouth Bay always showed a preponderance of immature plaice, while the proportion of the smallest fish below 8 inches was never less than one-third, and sometimes (*i.e.* during the winter quarter) exceeded three-fourths of the total number present.

9. The following table shows the average percentage of plaice of each size in the three bays, irrespective of seasonal differences, as shown by the two series of experiments respectively.

	Thistle and *Busy Bee*, 1895–8.			*Oithona*, 1901–2.		
	Start Bay.	Torbay.	Teignmouth Bay.	Start Bay.	Torbay.	Teignmouth Bay.
0–7 ins.	12	39	32	4	50	60
8–11 ins.	41	35	56	24	30	20
12–14 ins.	38	23	10	44	14	12
15 ins. and above	9	3	2	28	6	8

Thus the preponderance of large plaice over small in Start Bay, and of small plaice over large in the other bays, was even more marked during the *Oithona's* investigations than during the earlier series of experiments. The difference, however, is apparently attributable, not to any permanent change in the distribution and abundance of the fish caused by the closure of the bays, but principally to a temporary scarcity during 1901–2 of medium-sized plaice from 8 to 11 inches in length (three to four years old), caused by an unfavourable spawning season in 1898.

2. THE MIGRATIONS OF THE PLAICE.

In order to provide some definite information as to the movements of plaice to and from the bays, a considerable number of living fish were marked with numbered labels and set free in the autumn of 1901 and the early summer of 1902. After some preliminary experiments with other devices, Dr. Petersen's method was adopted. This consists in passing a small piece of silver wire through the dorsal edge of the body, about half-way down, between two of the interspinous bones below the base of the dorsal fin, and in attaching a couple of special bone buttons to the wire, one on the upper (or eyed) side, and one on the lower (or blind) side. One, and in some cases each, of the buttons bore a distinctive number stamped upon it. The numbered bone button on the upper side was advantageously replaced in some of the experiments by a thin oval disc of brass, also numbered. By this modification of Petersen's method the obliteration of the number by wear and decay of the bone was obviated, and the fishes appear to have suffered little, if any, inconvenience. The only observed injuries caused by the labelling were due to an accidental slackness of the wire in two or three cases, thus causing the hinder margin of the lower button to catch and cut into the skin. In the great majority of cases, however, the fish were recovered in good condition.

Neglecting the preliminary trials, the marking experiments fall into two groups: (1) fish marked and liberated in the bays in the autumn of 1901; and (2) fish marked and liberated outside the bays in the early summer of 1902. The details of liberation and recovery are given in Table XXV.

I. Start Bay.

Four batches of marked plaice were liberated in Start Bay between the 2nd October and the 9th November, 1901. During October 159 were marked, and during November 108, making a total of 267. Of these 62 fish had been recovered to the end of July, 1903, *i.e.* 23½ per cent. Of these 34, *i.e.* 13 per cent., were recovered in the first six months, and 23, *i.e.* 8½ per cent., in the second six months, making a total of 21½ per cent. recovered within one year of liberation. The size of the fishes marked varied from 17·5 cm. to 46 cm., *i.e.* from

7 to 18 inches. The following table shows the number of fish of each size which were marked, and also the number of each size which have been recovered.

TABLE XX., *showing the numbers and sizes of Plaice marked in Start Bay, and the numbers recovered in successive periods inside and outside the bay.*

Length on liberation.	Total marked.	Total recovered.	First half-year.		Second half-year.		Second year.		TOTAL.		
			*In-side.	Out-side.	In-side.	Out. side.	In-side.	Out-side.	In-side.	Out-side.	Locality unknown.
7–8 inches .	9	1	1	—	—	—	—	—	1	—	—
9–10 ,, .	27	5	2	1	1	—	—	1	3	2	—
11–12 ,, .	69	18	1	10	5	2	—	—	6	12	—
13–14 ,, .	125	30	5	11	3	7	2	1	10	19	1 (1st ½-year)
15–18 ,, .	37	2	—	1	—	—	—	1	—	2	—
Size uncertain.	—	6	1	—	—	2	—	—	1	2	3 (2nd ½-year)
Totals . .	267	62	10	23	9	11	2	3	21	37	4
			33		20		5				
Locality unknown	—	—	1		3		—				
Grand total .	267	62	34		23		5				
Per cent. of total marked		23½ %	13 %		8½ %		2 %		8 %	14 %	1½ %

It is worthy of notice that the percentage of recoveries in the case of the largest and the smallest fish is very small. In the case of plaice from 9 to 14 inches in length at the time of liberation, 24 per cent. have been recovered, *i.e.* one out of every four; whereas of the fishes from 7 to 8 inches in length, only one out of nine has been recovered, and of those of 15 inches and upwards only two out of thirty-seven. It will be seen in the sequel that the explanation of this difference is probably to be found partly in the facts that the smallest fishes remain within the bays, and are, therefore, not liable to be captured by the trawlers in the ordinary way during the first year, and that the largest fishes tend to migrate away from the Brixham waters altogether, probably for the most part to the Eddystone trawling-grounds (cf. No. 176, caught on May 23rd, 1902, off the Eddystone).

The table shows further that nearly twice as many fish were recovered outside the bay as were found within its limits. The proportion borne by "outside" to "inside" captures is seen to increase pretty regularly with the size of the fish, the immature fish from 7 to 10 inches having been found mostly inshore, and the fish of the largest size-group only offshore. The smaller mature fish, *i.e.* from 11 to 14 inches, show, however, no such regularity when the season of the year is taken into consideration. During the first half-year, which, it will be borne in mind, included the winter period, twenty-one fishes were recovered outside, as against only six inside the bay. During the second half-year, extending from May to November, as many of these fishes were recovered inside the bay as outside.

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* NOTE.—The limit between "inside" and "outside" the bays in these tables is a purely geographical one, and does not strictly correspond with the trawling limits of the Devon Sea Fisheries Committee. Similarly the percentage of recoveries inside the bays is not to be taken as a measure of "poaching" on the part of the trawlers, since the returns include the captures by seiners, rod-fishermen, and the *Oithona* itself, as well as by trawlers.

The explanation of these facts becomes obvious upon a perusal of the detailed tables in which the localities of capture are recorded in chronological order. It will be seen that during October and November the fish were mostly found in Start Bay, but during December, January, and March most of the recoveries were made at considerable distances from the bay in deep water, especially on the Spion Kop ground, eight to ten miles off Beer Head, and on the Biscuit Dust ground, some twelve to fifteen miles off the same headland. During April and May the fish were still being recovered offshore, but nearer to the bay than during the preceding period, the ground locally known as the Corner being apparently the chief rendezvous of the fish at this season.* During the latter part of May and the succeeding summer months until October a considerable number of the fish were again recovered inshore, mostly in Start Bay, but one at any rate (No. 293) in Torbay.

There can be no doubt, therefore, that a large proportion of the plaice to be found in Start Bay make a periodical migration to the offshore grounds on the approach of winter. Out of a total of twenty-six fish recovered from December to April (both inclusive) four at most were found in the bay, and two of these were taken on December 1st, while the outward migration was still in progress. It has already been seen that this migration is for the most part limited to the fishes of 11 inches and upwards, *i.e.* to those which have attained the average size of maturity, and Dr. Kyle observed that the majority of the plaice recovered offshore from January to April in this experiment were either spawning or spent.

Analysis of the records also shows that there is no one route of migration, but rather a series of lines radiating fanwise from the bay in directions varying between N.N.E. and E. The smaller mature fish (between 11 and 13 inches) appear to have taken the shallower gradients to the northward, ultimately reaching the Spion Kop ground after passing Torbay and Teignmouth Bay (cf. Nos. 260, 279, 203, 210, 217, and 130). The larger fish, on the other hand, of about 15 inches in length, appear to migrate more or less directly to the Biscuit Dust ground (cf. Nos. 207, 257, and 305), though the capture of one of these large fishes in Torbay on December 17th (No. 1) suggests that even for the larger fishes the actual route may be somewhat to the northward at the commencement of the migration.

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* Also of the trawlers, who follow the fish in their migrations (cf. p. 440).

After this spawning migration has taken place the smaller fishes tend to return again to the bays. The largest fishes may either return to the bays (cf. Nos. 57, 75, 139, 10, 252, and 293), or may pass to the south and west of Start Point altogether (cf. Nos. 176, 308, and 277).

II. Torbay.

Two small batches of marked plaice were liberated in Torbay—eighteen fish on October 10th, 1901, and seven fish on November 14th, making a total of twenty-five fish. Six of these have been recovered altogether, for the details of which reference may be made to the detailed table and the following analysis of the sizes of the fishes marked. The experiment was on too small a scale to render discussion of details necessary.

Table XXI., *showing the numbers and sizes of Plaice marked in Torbay, and the numbers recovered in successive periods inside and outside the bay.*

Length.	No. marked.	No. re-caught.	First half-year.		Second half-year.		Second year.		Total.	
			Inside.	Outside.	Inside.	Outside.	Inside.	Outside.	Inside.	Outside.
7–8 inches .	4	—	—	—	—	—	—	—	—	—
9–10 ,, .	5	2	2	—	—	—	—	—	2	—
11–12 ,, .	11	3	2	1	—	—	—	—	2	1
13–14 ,, .	3	1	—	—	—	—	1	—	1	—
15–18 ,, .	2	—	—	—	—	—	—	—	—	—
Total . .	25	6	4	1	—	—	1	—	5	1
			5		—		1			
Per cent. of total marked . .		24 %	20 %		—		4 %		20 %	4 %

III. Teignmouth Bay.

Three batches of marked fish were liberated in Teignmouth Bay—fifty-three fish on October 9th, twenty-one on November 13th, and twenty-eight on November 29th, making 102 in all. Of these thirty-four have been recovered, eighteen (18 per cent.) in the first half-year, and nine (9 per cent.) in the second half-year, making a total of twenty-seven (27 per cent.) within one year of liberation. The sizes of the fishes marked may be gathered from the accompanying table.

TABLE XXII., *showing the numbers and sizes of Plaice marked in Teignmouth Bay, and the numbers recovered in successive periods inside and outside the bay.*

Length.	No. marked.	No. recaught.	First half-year.		Second half-year.		Second year.		Total.	
			Inside.	Outside.	Inside.	Outside.	Inside.	Outside.	Inside.	Outside.
7–8 inches .	32	5	2	—	1	2	—	—	3	2
9–10 ,, .	37	16	2	5	3	2	—	4	5	11
11–12 ,, .	17	10	2	6	—	1	—	1	2	8
13–14 ,, .	13	3	1	—	—	—	—	2	1	2
15–18 ,, .	3	—	—	—	—	—	—	—	—	—
Total . .	102	34	7	11	4	5	—	7	11	23
			18		9		7			
Per cent. of total marked		34 %	18 %		9 %		7 %		11 %	23 %

It will be seen that the general percentage of recoveries (34 per cent.) is much higher for this bay than for Start Bay, and that half the fishes from 9 to 12 inches were recovered; whereas in the Start Bay experiments only a quarter of the fishes of this size, and less than 24 per cent. of the total number liberated, were recaught.

The fact that none of the thirty-two fishes from 7 to 8 inches were recaught after the first year tends to show that the explanation advanced above, in the Start Bay section, as regards the small percentage of these fishes caught, is not sufficient to account for all the facts. One year's growth (from 3 to 4 inches for fishes of this size) would bring them to a length of 10 to 12 inches, at which size they would be capable, as the records show, of undertaking the ordinary migrations, and would thus be liable to capture by the trawlers outside the bays. The probability is that the rapid growth of fishes of this size causes the fish to suffer injury towards the end of the summer owing to the rigid character of the labels with which they are marked. The fish grow in thickness, but the length of the silver wire connecting the buttons remains the same. The consequence is that the buttons press too severely upon the skin and, by laceration, cause wounds of a serious character, or wear off altogether. I have seen good examples of this in our North Sea investigations. The statistics of capture of these small marked fishes should, therefore, be treated cautiously, and the fact that none of the fishes marked of this size-group (7 to 8 inches) have been recaptured after the first year in any of the Devon experiments receives an explanation which it would otherwise be difficult to supply.

Turning again to the table, it should be noticed that fully twice as many fish from this experiment have been recovered outside the bay as have been caught inside, and that after the first year none of the fish were recovered within the bay, although as many as seven (= 20 per cent. of the total recovered, and 7 per cent. of the total marked) were taken during the second year outside the bay. We see further that after the first half-year the recoveries within the bay were limited to the immature fish below 11 inches in length. Since fishes exceeding this size formed a third of the total marked, this feature in the results cannot be without significance.

If, for the reasons already given, we omit the smallest fishes (7 to 8 inches) altogether from consideration, we find that 41½ per cent. of the Teignmouth Bay fish were recaught,—31½ per cent. in the first year and 10 per cent. in the second year. During the whole period 11 per cent. were recaptured in the bay and 30 per cent. outside. In the Start Bay experiments only 23½ per cent. of the fish were recaught, —21½ per cent. in the first year and 2 per cent. in the second year. Of the entire number recovered, 1½ per cent. had no locality assigned to them, 8 per cent. were recaught in the bay, and 14 per cent. outside the bay (see Table XXIV.).

The difference between the total percentages recovered (18 per cent.) in the two experiments appears to be an approximate measure of the proportion of Start Bay fish which migrated altogether outside the Brixham trawling-grounds, or acquired habits which placed them beyond the reach of the fishermen during the period under discussion, —10 per cent. escaping during the first year, and 8 per cent. during the first nine months of the second year.

The high percentage of fish recovered from the Teignmouth Bay experiments during the second year, coupled with the fact that after the first half-year none of the mature fish were taken in the bay, shows that this bay in no way approaches the conditions of a self-contained area, so far as plaice are concerned; but that it is essentially a rearing ground (or nursery) for young plaice, which leave the bay even before maturity is reached, and do not, as a rule, return to it.

Turning now to the detailed tables showing the localities of capture, it is obvious at a glance that the Teignmouth Bay plaice, on the approach of winter, migrate eastwards towards the same grounds as those visited by the Start Bay fish. Doubtless the larger fishes which undertake this migration spawn on the same grounds. Accepting, however, 11 inches (= 28 cm.) as the average size at maturity, it cannot escape notice that many of the fishes which had undertaken this migration were too small to be sexually mature (cf. Nos. 219, 225, 247, 337, and 343). It will also be noticed that whereas the Start Bay fish tended to return to Start Bay in the following summer and autumn after the spawning migration was over, the Teignmouth Bay showed no general tendency to return to Teignmouth Bay,—several fishes recovered during the following summer having been found either in Torbay or Start Bay or in their immediate neighbourhood (cf. Nos. 268, 236, 320, and 357).

The details of capture thus confirm the results of the previous statistical treatment of these experiments. They show that Teignmouth Bay is an important source of supply of young plaice, both for the offshore grounds in the Brixham area and for the other bays to the southward. The upkeep of the general stock of plaice in the district would indeed appear to be largely dependent on the preservation from destruction of the young fish in this bay.

IV. OUTSIDE THE BAYS.

The three preceding sets of experiments in the bays were carried out in the autumn of 1901. In the early summer of 1902 Dr. Kyle marked and liberated a number of plaice outside Start Bay and Torbay in order to throw special light on the summer migrations. Eleven plaice were marked outside Start Bay on April 12th to 14th, and sixty-two plaice were marked and liberated midway between Berry Head and the Orestone on May 29th. As the recoveries in each case show the same general tendencies, they may be taken together. The following analysis shows the sizes of the fishes marked and the numbers recovered inside and outside the bays during successive periods. In comparing this table with the preceding tables referring to the bays, it should be borne in mind that the first half-year is now a summer and autumn period, and not a winter period, as in the previous experiments.

TABLE XXIII., *showing the numbers and sizes of Plaice marked outside Torbay and Start Bay, and the numbers recovered in successive periods inside and outside the bays.*

Length on liberation.			1st half-year.		2nd half-year.		2nd year.		Total.		
	Total marked.	Total recovered.	Inside.	Outside.	Inside.	Outside.	Inside.	Outside.	Inside.	Outside.	No locality.
7–8 inches	2	1	—	—	1	—	—	—	1	—	—
9–10 ,,	23	6	3	2	—	1	—	—	3	3	—
11–12 ,,	41	16	7	7	—	—	1	—	8	7	1 2nd hf.-yr.
13–14 ,,	7	3	1	1	—	—	—	1	1	2	—
15–18 ,,	—	—	—	—	—	—	—	—	—	—	
Totals	73	26	11	10	1	1	1	1	13	12	1
			21		2		2				
Locality unknown		—	—		1		—				
Grand total	73	26	21		3		2				
Percentage of total marked		36 %	29 %		4 %		3 %		18 %	16½ %	1½ %

It will be seen that the fishes marked were mostly from 9 to 12 inches in length. The percentage of recoveries over the whole period distinctly exceeds that for Start Bay, and even surpasses that for Teignmouth Bay, viz. 36 per cent. For the first twelve months the percentage is 33 per cent. Unlike the result of the Start Bay and Teignmouth Bay experiments, the majority of the fish were recovered inside the bays, and almost entirely during the first half-year.

On examining the detailed records showing locality of capture, it will be seen that most of the fishes recovered during the first half-year were either travelling towards or had made their way into Start Bay. Only one fish (No. 347) was recovered in Torbay, a fact which is all the more remarkable since the great majority of the specimens were liberated in the mouth of that bay. On November 16th one of the Torbay fish (No. 373) was recovered off the Eddystone by a Plymouth trawler. The movements of the fish during this season were, therefore, very similar to those of the Start Bay fish on their return migration from the spawning grounds, and they confirm the interpretation which was adopted in the section dealing with the Start Bay fish as regards the return migration.

During the second half-year, *i.e.* in the spring of 1903, one fish at least was recovered on the Spion Kop ground (No. 328), and the records of the fishes numbered 383 and 361 tend to show that during June and July the remainder of the fish were again returning to Start Bay.

In the following table the percentage of marked fish recovered from the various experiments, exclusive of the smallest fish from 7 to 8 inches, is shown side by side for the different periods for the sake of easier comparison. It has not been thought necessary to repeat the figures given in the separate tables concerning the totals of *all* sizes marked.

TABLE XXIV., *showing percentage of Plaice of* 9 INCHES AND UPWARDS *marked and recovered in the various experiments.*

	Numbers.		Percentages of totals marked.									
			First half-year.		Second half-year.		Second year.		Entire period.			
Locality.	No. marked.	No. recovered.	Inside.	Outside.	Inside.	Outside.	Inside.	Outside.	Inside.	Outside.	Locality unknown.	Total % recaught.
tart Bay . .	258	61	3·5	8·9	3·5	4·2	0·8	1·3	7·8	14·3	1·5	23·6
orbay . .	21	6	19·0	4·7	—	—	4·7	—	23·8	4·7	—	28·6
eignmouth Bay	70	29	7·1	15·7	4·3	4·3	—	10	11·4	30·0	—	41·4
ll the bays combined *	349	96	5·1	10·0	3·4	4·0	0·9	2·8	9·4	16·9	1·1	27·5
utside the bays	71	25	15·5	14·0	—	1·4	1·4	1·4	16·9	16·9	1·4	35·2

* In this combination of the bays, Start Bay fish recovered in Torbay and Teignmouth Bay, or *vice versâ*, have been treated as "inside," not "outside," as in the case of the tables for each bay separately.

TABLE XXV. *Records of Plaice-marking Experiments.*

START BAY.

PARTICULARS OF LIBERATION.	PARTICULARS OF RECOVERY.					
Date. No. of fish. Locality.	Date.	No. of fish.	Locality.	Initial size.	Ultimate size.	Sex.
BATCH I. Oct. 2nd to 4th, 1901. 99 Plaice (from hauls No. 16, 18, 19, and 20). Inside Skerries, from centre of bay northwards. Labels : bone buttons.				cm.	cm.	
	1901. Oct. 11	98	Start Bay	33	—	—
	,, ,, 21	90	,,	32	—	—
	,, Nov. 21	95	Off Dartmouth	30	33	—
	,, Dec. 17	1	Torbay	37	—	—
	1902. Jan. 15	84	15 miles off Berry Head (Start W. to W.N.W.)	34	—	—
	,, ,, 20	110	Offshore off Berry Head	36	—	♂ s.
	,, Feb. 13	120	Offshore in 25 fms.	30	—	♂ s.
	,, Mar. 20	130	"Spion Kop"	30	31·5	♂ s.
	,, ,, 22	135	Off Berry Head	28	29·5	♀ s.
	,, April 1	12	12 miles S. of Start Point	32	34	♀ s.
	,, ,, —	103 (or 105)	6 to 12 miles off Start Bay	32·5 (or 32)	—	—
	,, ,, 23	87	"The Corner" off Start Bay	33·5	35·5	♂ s.
	,, May 8	two	Off the Start	? ?	—	—
	,, ,, 11	28	Start Bay	31	—	—
	,, ,, 24	88	,,	31	33	—
	,, July 9	144	,,	35	38	♂ s.
	,, ,, 14	123	,,	28	30·5	—
	,, ,, 30	55	,,	26	33	—
	,, Aug. 30	57	,,	32·5	39·5	—
	,, Sept. 1	75	,,	36	35·5	—
	,, Oct. 1	139	,,	34	38	—
	,, ,, 2	10	,,	35	40·5	—
	1903. Feb. 24	18	10 miles off Sidmouth	35	43	—
II. Oct. 11th, 1901. 6 Plaice (from haul 21). Centre of Start Bay. Labels : brass discs.	1901. Dec. 8	260	Torbay	32	—	—
III. Oct. 29th, 1901. 54 Plaice (from special hauls)—35 between Redlap and Dartm. Fairway, 1½ m. from shore; remainder 1½ m. E. of Torcross. Labels : bone buttons.	1902. Mar. 27	145	Spion Kop	32·5	34	♀ s.
	,, April 11	163	,,	34	35·5	—
	,, ,, 26	159	,,	33	35·5	—
	,, May 23	176	Off Eddystone	35	35	♂ s.
	,, June 18	165	2 miles off Downend	28	—	—
	1903. April 2	184*	8 miles off Downend	46	48	—
	,, July 28	155	Start Bay	26·5	39	—
IV. Nov. 7th to 9th, 1901. 108 Plaice (from hauls No. 7, 8, 9, and a special haul on Nov. 7th). Inside Skerries, from off Torcross to Dartmouth Fairway. Labels : bone buttons.	1901. Nov. 14	299	,,	36	—	—
	,, ,, 19	205	,,	21·5	21	—
	,, ,, 19	227	,,	37	—	—
	,, ,, 20	279	Teignmouth Bay	33	—	—
	,, ,, 29	219	Start Bay	33·5	33·5	—
	,, Dec. 1	207	12 to 15 miles off Beer Hd.	39	38	—
	,, ,, 1	276	Start Bay	34·5	—	—
	,, ,, 1	254	,, (+242 ?)	27	—	—
	,, ,, 2	257	12 to 15 miles off Beer Hd.	37·5	38	—
	,, ,, 5	218	2 to 5 miles off Berry Hd.	34·5	—	—
	,, ,, 9	204	Start Bay (?)	33	—	—
	1902. Jan. 25	305	In deep water off Beer Hd.	37·5	—	♂ s.
	,, Mar. 12	203	Off Beer, in 20 fms.	23·5	—	♂ s.
	,, ,, 22	307	Start Bay	25·5	25·5	—
	,, April—	210	Off Bridport	33·5	—	—
	,, ,, 2	217	Spion Kop	28·5	29·5	♂ s.
	,, ,, 23	222	Neighb'hood of Start Bay	36	36	♂ s.
	,, ,, 23	247	,, ,,	28·5	29·5	♂ s.
	,, May 10	202	4 miles off Dartmouth	28	32	—
	,, ,, 17	287	Offshore, off the Start	36	37 (*sic*)	—
	,, ,, 28	212	8 miles off Downend	35·5	38	—
	,, July 18	268	Back of New Ridge (3 miles off Downend)	34·5	38·5	—
	,, Aug. 11	252	Start Bay	32	37	—
	,, ,, 11	three	Locality unknown	? ? ?	—	—
	,, Sept. 13	308	Salcombe Range	33	38	—
	,, Oct. 17	29 (3 ?)	Torbay (3rd figure obscure)	34 ?	38	—
	1903. Feb. 6	277	20 miles S.W. of Start Pt.	27·5	34	—

* Doubtful ; see note p. 488.

TORBAY.

Particulars of Liberation.	Particulars of Recovery.					
Date. No. of fish. Locality.	Date.	No. of fish.	Locality.	Initial size.	Ultimate size.	Sex.
Batch V.				cm.	cm.	
Oct. 10th, 1901.	1901. Dec. 1	287	Torbay	23	—	—
18 fish (from haul No. 11).	,, ,, 1	289	,,	27·5	—	—
Torbay.	,, ,, 1	294	,,	30	—	—
Labels : brass discs.	1902. Oct. 16	298	,,	33	38	—
Batch VI.						
Nov. 14th, 1901.	1901. Dec. 1	325	,,	31	—	—
7 fish (from haul No. 15).	1902. May 6	327	12 miles off Start (latter bearing N.W. ?)	30	30(*sic*)	—
Torbay.						
Labels : brass discs.						

TEIGNMOUTH BAY.

Particulars of Liberation.	Particulars of Recovery.					
Date. No. of fish. Locality.	Date.	No. of fish.	Locality.	Initial size.	Ultimate size.	Sex.
Batch VII.				cm.	cm.	
Oct. 9th, 1901.	1901. Oct. 9	237	Off Dawlish	21	—	—
53 Plaice (from haul No. 7).	,, ,, 12	254	Teignmouth	29	—	—
Off Teignmouth.	,, ,, 12	263	Dawlish	21·5	—	—
Labels : brass discs.	,, ,, 12	265	Teignmouth	24·5	—	—
	,, ,, 30	278	Off Dawlish (caught with hook and line)	28	—	—
	1902. Jan. 13	256	Off Beer Head, in 20-25 fms.	28	—	—
	,, Feb. 6	219	Off Beer Head, in deep water	23	—	—
	,, Apl. 7	258	Teignmouth Bay, inside Ledge	27	31	—
	,, May 15	225	6 miles off Beer Head	20	23	—
	,, July 8	247	12 miles out from Torbay	21·5	—	—
	,, Sept. 4	268	Torbay	23·5	—	—
	,, ,, 10	236	Start Bay	25	30·5	—
	,, Oct. 11	248	Pole Sands, Teignmouth	21	26·5	—
	1903. Mar. 5	244	Spion Kop	27·5	34·5	—
	,, ,, 14	246	,,	27	37	—
Batch VIII.						
Nov. 13th, 1901.	1902. Mar. —	308	Off Sidmouth and Teignmouth	28	—	—
21 Plaice (7, and probably all, from hauls 11 and 12).	,, Apl. 8	314	Off the Start	29·5	—	—
Teignmouth Bay; liberated in three batches, off Minicombe, Dawlish, and Clerk Rock.	,, ,, 11	312	South of Beer Head, in 22 fms.	28·5	32	♂
	,, ,, 23	320	"The Corner" off Start Bay	32	—	—
Labels : brass discs.	,, July 10	313	Start Bay	31	—	—
	,, Nov. 10	305	Teignmouth Bay	24	30·5	—
Batch IX.						
Nov. 29th, 1901.	1901. Dec. 1	352	Teignmouth	35	—	—
28 Plaice (from special haul)	1902. Jan. 24	337	In deep water towards Portland (25 fms.)	24	—	—
Off Teignmouth 1 mile.	,, Apl. 11	340	South of Lyme	31·5	—	—
Labels : brass discs.	,, ,, 28	343	7 miles off Exmouth	23	—	—
	,, Apl. —	333	Off Teignmouth Bay	25·5	—	—
	,, May 14	355	3 miles off Mausands	23·5	27·5	—
	,, Oct. 11	335	Pole Sands, Teignmouth	24	26·5	—
	,, ,, 16	341	Babbacombe	25	30·5	—
	1903. Jan. 8	357	1 mile off Berry Head	23	30·5	—
	,, Feb. 7	350	Edge of Eastern Scruff	34	—	—
	,, Mar. 5	338	Spion Kop	33	38	—
	,, ,, —	339 (or 334	,,	26 (or 29·5)	35·5	—
	,, ,, 28	336	,,	31·5	39·5	—

OUTSIDE THE BAYS.

Particulars of Liberation.	Particulars of Recovery.					
Date. No. of fish. Locality.	Date.	No. of fish.	Locality.	Initial size.	Ultimate size.	Sex.
				cm.	cm.	
Batch X. April 12th and 14th, 1902. 11 Plaice. Two liberated 12 miles off Dartmouth (none recovered), and 9 liberated 6 miles S.S.E. from Dartmouth. Labels : bone buttons.	1902. Apl. 23	320	Neighbourhood of Start Bay	28	27 (*sic*)	♂ s. ?
	,, May 6	315	8 miles E. by N. from the Start	33	—	—
	,, July 19	314	Start Bay	35	—	—
	,, ,, 23	313	,,	32	—	—
Batch XI. May 29th, 1902. 62 Plaice. Liberated midway between Berry Head and Orestone. Labels : bone buttons.	1902. June 5	354	The Corner, 6 miles off Dartmouth	32·5	—	—
	,, ,, 14	343	4 miles off Downend	28	28	—
	,, ,, 21	360	10 miles off Downend	29	—	—
	,, ,, 21	364	2 miles off Mausands	27	—	—
	,, ,, 26	379	Start Bay	30·5	—	—
	,, July 8	369	Off Berry Head, amongst "The Hitches"	29·5	30	—
	,, ,, 10	322	New Ridge (3 miles off Downend)	23	24	—
	,, ,, 12	349	Start Bay	30	—	—
	,, ,, 17	338	2 miles off Downend	28	28	—
	,, ,, 19	365	Start Bay	24·5	26·5	—
	,, Aug. 30	342	,,	29	30	—
	,, Sept. 1	367	,,	29·5	33	—
	,, ,, 12	329	,,	25	27·5	—
	,, ,, 27	332	,,	27	27·5	—
	,, Oct. 2	344	,,	29	30·5	—
	,, 9	347	Torbay	29	35·5	—
	,, Nov. 16	373	Off Eddystone (Plymouth trawler)	30	—	—
	1903. Apl. 29	324	Torbay, just inside Berry Head	22	31·5	—
	,, May 1	328 (or 326)	Spion Kop	25 (or 26·5)	30	—
	,, ,, 27	336	(No locality ; found in fish store)	28	30	—
	,, June 16	383	5 miles off Berry Head	35	42	—
	,, July 27	361	Start Bay	29	37·5	—

In the above tables the letter "s" after the symbol of sex indicates "spawning" or "spent."

3. RATE OF GROWTH OF PLAICE.

By comparing the sizes of the marked plaice when recovered with their original size when liberated, it should be possible, if due precautions are taken, to obtain a fairly reliable measure of their rate of growth. Nearly seventy of the marked fishes described in the previous section were measured on recapture, partly by Mr. W. J. Sanders at Brixham and partly by Dr. Kyle. Mr. Sanders's measurements appear to have been taken in most cases to the nearest quarter-inch; Dr. Kyle's measurements—which, however, form the minority—were taken to the nearest half-centimetre. The original measurements of the fish at the time of liberation were all taken to the nearest half-centimetre.

In the following table the plaice, whose ultimate sizes were recorded, have been sorted out in order according to the number of days which elapsed between their liberation and recapture, and the increase in length of each fish has been given as recorded. It will be seen that the increments of growth for the same period vary considerably, and it is not certain that they are all reliable, especially in the case of fishes marked with bone buttons, the numbers on which were, in some cases, obscure. The increments of growth recorded cannot, therefore, be relied upon as an exact measure of the range in growth for any one period. The specimens have been further grouped according to the number of months between liberation and capture. The first month is taken to correspond with the period of thirty days from the sixteenth to the forty-fifth after liberation, the mean of the period being thus the thirtieth day. The second month covers the period from the forty-sixth to the seventy-fifth day, and so on. The fishes have been further sorted out, according to their original size, on liberation, into three groups: (1) fishes from 8 to 11 inches, inclusive (20 to 30 cm.); (2) fishes from 12 to 15 inches (30·5 to 40 cm.); and (3) fishes of 16 inches and upwards (40·5 cm. and upwards). Only one instance of the latter size, however, occurs, and it is a somewhat doubtful record. A distinction has also been drawn between the fishes liberated in the autumn of 1901 and those liberated in the spring of 1902, since the rate of growth in winter and summer is already known to differ considerably.

TABLE XXVI., *showing the Growth of marked Plaice, classified according to* (1) *season of liberation,* (2) *original size on liberation, and* (3) *period of growth in months of thirty days.*

Liberated in October and November.								Liberated on May 29th.			
Length on liberation.								Length on liberation.			
20–30 cm. (=8″–11″).				30·5–40 cm. (=12″–15″).				20–30 cm. (=8″–11″).			
Month.	Label.	Days.	Increase (cm.)	Month.	Label.	Days.	Increase (cm.)	Month.	Label.	Days.	Increase (cm.)
[O]	205	12	—	[O]	219	12	—	I.	343	16	--
II.	95	49	3·0	I.	207	24	—		369	40	0·5
IV.	307	133	—		257	24	0·5		322	42	1·0
V.	217	146	1·0	V.	145	149	1·5	II.	338	49	—
	312	149	3·5		163	164	1·5		365	51	2·0
VI.	355	166	4·0	VI.	222	167	—	III.	342	93	1·0
	247	167	1·0		159	179	2·5		367	95	3·5
	130	167	1·5		12	181	2·0	IV.	329	106	2·5
	135	169	1·5		287‡	189	1·0		332	121	0·5
	327	173	—	VII.	212	202	2·5		344	126	1·5
	258	180	4·0		87	202	2·0		347	133	6·5
	202	184	4·0		176	206	—			—	—
VII.	225	218	3·0	VIII.	88	234	2·0			—	—
IX.	123	284	2·5		268	252	4·0			—	—
X.	55	301	7·0	IX.	252	276	5·0			—	—
XI.	335	316	2·5		144	278	3·0			—	—
	341	321	5·5	X.	308	308	5·0			—	—
	236	336	5·5	XI.	57	332	7·0	XI.	324	334	9·5
XII.	305*	362	6·5		75	334	—	XII.	336	363	2·0
	248	367	5·5	XII.	139	362	4·0	XIII.	361	395	8·5
XIII.	357	405	7·5		10	365	5·5				
XV.	277	454	6·5		298	371	5·0				
XVI.	339†	484	9·5	XV.	338	461	5·0				
XVII.	244	512	7·0	XVI.	336	484	8·0				
	246	521	10·0	XVII.	18	508	8·0				
XXI.	155	637	13·0								
Original length: 46 cm.								*Original length: 35 cm.*			
XVII.	184§	? 520	2·0					XIII.	383	383	7·0

It will be seen from the table that for many of the months the number of records is too small to enable an accurate curve to be drawn representing the increase in size through each month of the year. A considerable number of fishes, however, were recaptured during the sixth month after liberation, and a fair number about the twelfth month. In the latter case, however, the records for the eleventh and thirteenth months may also be taken into consideration in order to enlarge the field from which the average for twelve months' growth may be derived. The following table, based on this method, shows the average increase in length for the plaice recovered after six months' and a full year's growth respectively.

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* Brass label (Batch VIII.). ‡ Bone label (Batch IV.).

† Record doubtful, possibly 334, in which case the increment would be only 6·0 cm.

§ Record doubtful, the date of capture being given as April 4th, 1902, in one place, and April 4th, 1903, in another. The latter, from other evidence, appears to be correct.

TABLE XXVII., *showing average increase in length of marked Plaice, recorded in the preceding table.*

Period of Growth.	Length when liberated.	
	20 to 30 cm.	30·5 to 40 cm.
Six months (Nov. to April) . .	2·3 cm. (7 fish)	1·4 cm. (4 fish)
Twelve months (XI. to XIII.) . .	5·9 cm. (9 fish)	4·8 cm. (6 fish)
,, omitting Nos. 335, 75, and 336	6·9 cm. (7 fish)	5·7 cm. (5 fish)

In the above calculation, as regards the half-year's growth, it has only been possible to consider the fishes liberated in October and November; but for the full year's growth the records derived from the autumn and spring fish have been combined. The average increase in size during the first six months is seen to have been 2·3 cm. (⅞-inch) in the case of seven fish belonging to the smaller group, and 1·4 cm. (½-inch) in the case of four fishes belonging to the larger group. This growth, however, included the winter period, and a reference to the detailed table shows that during the summer months the rate of growth was considerably higher. In the case of the fish liberated on May 29th the average growth of two fishes in three months was 2·2 cm. (⅞-inch), and of four fishes in four months 2·7 cm. (1⅛ inches). These figures refer to the smaller group of fishes from 8 to 11 inches in original length. During the winter period, therefore, these fishes grow no more in six months than they attain in three months during the summer.

For the entire year's growth the average growth of nine fish of the smaller group was 5·9 cm. (2⅓ inches), and for six fishes of the larger group 4·8 cm. (1⅞ inches).

In each case it is seen that the larger fishes grow more slowly than the smaller fishes, a result which, indeed, is shown by the averages for almost every period specified in the detailed table.

As regards the full year's growth, however, it will be seen in the detailed table that several exceptionally low increases occur among the records, viz. Nos. 335 (2·5 cm.), 75 (0·0 cm.), and 336 (2·0 cm.). As the possibility of errors of measurement or identification has to be borne in mind, we may omit these specimens altogether in order to get an idea of the most usual growth for the twelve months' period. The averages then become 6·9 cm. (2¾ inches) for seven fishes of the smaller group, and 5·7 cm. (2¼ inches) for five fishes of the larger group. If allowance be made for shrinkage of the fish after death before remeasurement, the full year's growth would appear to have been about 3 and 2½ inches in the case of the two groups respectively. The true average growth for plaice of the smaller size-group would probably, indeed, slightly exceed the figure assigned, since, as pointed out in the previous section, relatively few of the 8-inch fish were recovered, and we have seen in this section that the rate of growth was inversely proportional to the original size of the fish.

This experimental result agrees with the evidence of the trawling records. Station VII. in Teignmouth Bay is the chief rearing-ground for small plaice, and a representative haul on that station on October 9th (Table D, haul 7) shows that intervals of 4 inches and about 3½ inches separated the sizes at which the plaice were most abundant, viz. 4 inches, 8 inches, and 11 or 12 inches. These sizes, according to Petersen's method, may be taken as the average sizes of plaice of successive yearly groups, and the intervals between them as the annual increments of growth (cf. also Torbay, same table, Station IV., hauls 1, 4, 8, and 34).

SECTION III.

The Reproduction of the Flat-Fishes.

By

H. M. Kyle, M.A., D.Sc.

1. SPAWNING PERIOD OF THE PLAICE.

"The spawning periods of the food-fishes have been fully ascertained for the east coast of Scotland by Dr. Fulton and other Scottish workers, and the present occasion afforded a good opportunity of determining the spawning time of the plaice on the south-west coast of England. Mr. Cunningham's work, published in previous numbers of this Journal, and in more compendious form in his book on *Marketable Marine Fishes*, covers the whole field of fishery investigation, and forms therefore an excellent basis for more definite and detailed research. The spawning period of the plaice, for example, is given as January, February, and March for the North Sea and English Channel, and in a general way this is quite correct, but it is somewhat vague. The plaice of the Bristol Channel also spawn during the months mentioned, but on the whole later than those of the English Channel. It is evident, therefore, that we must ascertain the periods at which most plaice are spawning or have spawned, in other words the maximum spawning period as it is generally called. The difficulties in the way of ascertaining this accurately arise from the facts that all fish do not spawn exactly at the same time, and that one fish may take two or more weeks in getting rid of all its spawn. We cannot, therefore, delimit the maximum spawning period to less than two to three weeks, and if we allow for fluctuations in different years, one month is the nearest approximation we can make.

"It is well known that the spawning period extends over a number of months, and isolated cases may occur much earlier and later than the usual period. Specimens examined during November seemed, especially the males, quite ready to spawn, but it was not until the middle of December that spawning was actually observed.

"The observations made during December, January, and February are summarised in the following table, the details with regard to sizes being given in Table XXIX. The various conditions which the reproductive organs may show are classified under three headings: (1) maturing, (2) spawning, (3) spawned. As there has always been some dubiety with regard to the demarcation of these stages from one another and from the immature condition, a description may be given of the symptoms chosen as guides for the present work. During the period when the observations were made the difficulty of distinguishing the immature from the mature, whether male or female, is reduced to a minimum. In every case the reproductive organs and not merely the external appearance were examined, and during this period the males only give some trouble. When the testes are clearly developed, but no milt is running, the males are considered to be maturing; if milt comes freely or on slight compression, they are considered as spawning. If the testes are flaccid and a little milt can still be expressed, the males are put down as having spawned. Doubtful specimens are not entered on the list.

TABLE XXVIII. *Spawning Period of the Plaice.*

	December.		January 15th.		January 25th.		February 10th.	
	♂	♀	♂	♀	♂	♀	♂	♀
Maturing .	22	26	164	91	—	9	—	11
Percentage	*88*	*93*	*71*	*65*	—	*32*	—	*16*
Spawning .	3	1	66	27	2	3	35	10
Percentage	*12*	*3·5*	*29*	*19*	—	*11*	*100*	*14*
Spawned .	—	1	—	22	—	16	—	49
Percentage	—	*3·5*	—	*16*	—	*57*	—	*70*
Total .	25	28	230	140	2	28	35	70

Total, 292♂ + 266♀ = 558.

"It appears from the table that up to the 15th January the great majority of the males were still maturing, and that less than 30 per cent. could be considered as spawning. After that date all the specimens examined were spawning. The percentages for both sexes agree in showing that the maximum spawning period is later than the 15th of January.

"The females are grouped under the same three headings as the males. Maturing females mean those in which the ova are developing, as far as the stage where a few ova are clear, *i.e.* ripe, but have not yet made their way into the oviduct. Spawning females include all those which have ripe ova in the oviduct, no matter what stage the ovary may be in as regards depletion or emptiness. Spawned females are those in which the ovary is flaccid, and very few, if any, ripe ova still remain.

"The number of maturing females diminishes from 93 per cent. in December to 65 per cent. on the 15th of January, and lastly to 16 per cent. on the 10th of February. The spawning females are at no time numerous, the highest percentage being 19 on the 15th of January. The percentage of spawned females increases from 3·5 in December to 16 on the 15th, 57 on the 25th of January, and 70 on the 10th of February.

"The maximum spawning period may be said to have been reached when 50 per cent. of the specimens observed have spawned, and to have passed when 70 per cent. is attained. On the other hand, if more than 60 per cent. of the specimens have not yet begun to spawn it is evident that the maximum spawning period has not yet arrived. Consequently, the spawning of the plaice on the south-west coast of England is at its height during the third and fourth weeks of January. This holds good for the year under observation, viz. 1902, and if we allow one week on either side for probable fluctuations in other years, we conclude that the maximum spawning period lies between the third week of January and the second week in February.

"From the fact that a number of specimens had not yet begun to spawn on the 10th of February we may conclude that the spawning period is prolonged into March. No specimens were examined during the latter month, but all those seen during the first fortnight of April had finished spawning.

"The number of specimens examined during the present investigations is sufficiently large to test the suggestion made by Holt* that the largest fish of a species spawn the earliest as a rule. The single specimen which was found to have spawned in December was 40 cm. (16 inches), and of the numbers examined in January the small (from 11 to 15 inches) and the large (over 15 inches) are equally distributed amongst the maturing and spawning specimens, but the large clearly preponderate amongst the spawned. Holt's conclusion is justified only partly therefore, and the records for February point in the reverse direction, as the largest specimens examined, 53, 55, and 65 cm. (21 to 26 inches), have not yet begun to spawn. Here, as elsewhere, considerable variation occurs and definite conclusions are hard to find.

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* *Journ. M. B. A.*, vol. ii. p. 370.

TABLE XXIX.

Spawning Period of Plaice.

	MATURING.								SPAWNING.								SPAWNED.								TOTAL MATURE.		
	DEC.		JANUARY. 15th.		JANUARY. 25th.		FEB. 10th.		DEC.		JANUARY. 15th.		JANUARY. 25th.		FEB. 10th.		DEC.		JANUARY. 15th.		JANUARY. 25th.		FEB. 10th.				
cms.	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂ + ♀
22	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
23	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
24	—	—	5	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	6
25	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
26	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	3
27	—	—	3	1	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	5	1	6
28	1	—	12	—	—	—	—	—	—	—	1	—	—	—	2	—	—	—	—	—	—	—	—	—	16	—	16
29	—	—	9	—	—	1	—	—	—	—	4	—	—	—	6	—	—	—	—	—	—	—	—	2	19	3	22
30	3	1	11	—	—	—	—	1	2	—	5	1	—	—	5	1	—	—	—	1	—	1	—	1	26	7	33
31	1	2	12	2	—	—	—	1	—	—	2	1	1	—	3	—	—	—	—	—	—	—	—	—	19	6	25
32	5	1	23	2	—	—	—	1	—	—	6	—	—	—	3	1	—	—	—	—	—	—	—	1	37	6	43
33	—	1	11	1	—	1	—	1	—	—	9	—	—	—	3	1	—	—	—	—	—	—	—	5	23	10	33
34	2	3	13	3	—	—	—	—	—	—	6	1	—	—	4	—	—	—	—	—	—	—	—	7	25	14	39
35	5	2	19	4	—	1	—	—	—	—	5	2	—	—	2	1	—	—	—	3	—	—	—	—	31	13	44
36	1	4	13	4	—	1	—	—	—	—	6	1	1	—	3	—	—	—	—	—	—	1	—	2	24	13	37
37	—	—	12	6	—	1	—	2	—	—	—	1	—	—	3	2	—	—	—	1	—	1	—	1	15	15	30
38	2	—	6	1	—	1	—	—	—	—	5	2	—	—	—	2	—	—	—	1	—	—	—	5	13	12	25
39	—	2	2	11	—	—	—	—	—	—	5	3	—	—	—	—	—	—	—	—	—	1	—	3	7	20	27
40	—	2	3	5	—	1	—	—	—	—	3	3	—	2	—	—	—	1	—	—	—	—	—	4	6	18	24
41	—	1	3	6	—	—	—	1	—	—	2	1	—	—	—	—	—	—	—	2	—	1	—	4	5	16	21
42	—	1	2	4	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	1	—	—	—	2	3	10	13
43	—	2	—	4	—	—	—	—	1	1	4	3	—	—	—	—	—	—	—	1	—	—	—	1	5	12	17
44	—	—	—	8	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	—	1	—	13	13
45	—	1	1	6	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	3	—	1	—	3	1	16	17
46	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	1	—	1	—	1	—	11	11
47	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	3	3
48	—	—	—	1	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	1	—	1	—	5	5
49	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	6	6
50	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	2	—	4	4
51	—	—	—	2	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	4	4
52	—	—	—	3	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	2	—	—	—	7	7
53	—	1	—	3	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	5
54	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	2	2
55	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	2	2
56	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	—	4	4
57	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	3	3
58	—	—	—	1	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	1	—	—	—	—	—	4	4
59	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
61	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
62	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
63	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
65	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Total	22	26	164	91	—	9	—	11	3	1	66	27	2	3	35	10	—	1	—	22	—	16	—	49	—	—	558

2. SPAWNING GROUNDS.

"It has been pointed out, under the section describing the migration of the plaice, that the majority of the specimens of this species travel some distance from the inshore waters in order to spawn. The largest plaice spawn in 30 to 35 fathoms some 20 to 25 miles offshore, whilst the medium-sized spawn in 25 to 30 fathoms along the line from Start Point to Portland. Some, however, travel but a short distance from the bays, and a few seem actually to spawn within territorial waters.

"During December, 1901, a haul in the deep water (20 fathoms) off Dartmouth Fairway gave, amongst a number not yet ripe, two males with the milt running freely, one spawning female, and one already spawned. During January two similar males and two spawning females were obtained in 15 to 20 fathoms water, whilst eight females had already spawned. In February a score of spawned females was obtained about the same place.

"It is possible that the spawned specimens had migrated outward to the 25-fathom line and returned, but the presence of the spawning males and females at depths less than 20 fathoms renders it probable that all those obtained in Start Bay during January had spawned there. The number was not great. Very few plaice, small or large, are obtained in Start Bay during January.

"The number of spawning and spawned plaice found in Torbay and Teignmouth Bay was still smaller. The depth in these bays, it will be remembered, is under 12 fathoms, where one would not expect to meet spawning plaice. In Torbay, near Berry Head, one spawning male was obtained in December, and two large females (22 and 23 inches) which had already spawned in January. During the latter month, also, three large spawned females were got in Teignmouth Bay. It has been remarked by Fulton that large gravid females occur within territorial waters during the spawning season, and it is probable that the specimens found in Torbay and Teignmouth Bay were of that nature and had not migrated from the bays.

"Of the remaining species of food-fishes which the trawl captured in the bays, only two were found in the spawning condition. During March and April spawning and spawned dabs were found all over the area, within, but mostly without, the territorial waters, whilst towards the end of April two spawning brill (one male and one female) were obtained in Teignmouth Bay. No comment need be made on the dabs, as their ubiquitous nature and habits are well known. The occurrence of spawning brill in less than 12 fathoms of water is, however, quite exceptional, and it is interesting to note that Holt records the same phenomenon, also in Teignmouth Bay.

"The migratory round-fishes—herring, mackerel, and sprat—spawn in Torbay and Teignmouth Bay during the spring, summer, and autumn, but as these are captured by seines and not by trawls they do not concern us here.

3. AVERAGE SIZE AT FIRST MATURITY.

"The size at which fish become mature for the first time is of the greatest interest from the biological standpoint. It marks the stage where the species begins to reproduce its kind, and if for the moment we regard this as having been determined by natural selection, we may use the convenient terms of that theory in order to grasp the great significance of the line which divides the immature from the mature. It would be more correct to speak of age rather than size, but for present purposes the terms are interchangeable, whilst 'average size' conveys as yet more meaning to naturalists than 'average age.'

"We might say, then, that natural selection has regulated the size at which each species becomes mature for the first time, as it is of the greatest importance to the species under natural conditions that its individual components should reproduce as early as possible. If there is any risk of the species becoming exterminated, that is to say, if its enemies are many, then the sooner its individuals reproduce the greater will be the chances of the species surviving. Conversely, if its enemies beyond a certain size are comparatively few, so that the inevitable 'struggle' is *within* the species, then the later the stage of first maturity the stronger will be the individuals and the chances of extinction from ordinary causes practically nil. The latter seems to have been the condition of the plaice before man ventured on the deep-sea trawling, and even in these days the new fishing-grounds which are being opened up testify to the same thing. When man appears the conditions are slowly reversed, the large fish apparently grow scarcer, the average size of the race or species is consequently lowered, and a premium placed upon early reproduction. Is the species able, however, to adapt itself to the requirements of its new enemy? Would the average size at which the individuals reproduce for the first time —which size tends to be raised under natural conditions—become lower? In other words, would the individuals under the strain of the new conditions become mature in their third year, say, instead of their fourth as formerly?

"The circumstances which have given rise to the suggestion of this possibility are the following. Man's influence on the deep-sea fishing has gradually spread during the past century from the English Channel northwards, over the North Sea, and within the past twelve years on to Iceland. The average size* at which the female plaice of the southern portions of the North Sea reproduce for the first time is 13 to 14 inches, and the smallest mature female so far recorded is 9 inches.† The largest immature female has been 17 inches. In the northern portions of the North Sea the average size is 15 to 16, whilst the smallest mature and largest immature recorded are 12 and 17 inches respectively. The plaice of Iceland have not yet been closely examined, but they seem to have even larger proportions. The difference between the plaice of the southern and northern portions of the North Sea is just one year's growth. Further, the characters of the adults of the former group resemble those of the younger stages of the latter.

"These problems have already been discussed in a previous paper, and it was left an open question as to whether man's influence, or simply differences in the environment had brought about these differences between the southern and northern North Sea plaice. Further observations and records incline me to lay more stress on the selection exercised by man, whilst not forgetting the possibility that the environmental conditions may play some part. The new records‡ referred to are those of a group of small spawning plaice discovered during March, 1901, near the Borkum Reef in the German Bight. The sizes of the spawning females varied from 21·3 to 26·2 cm. (8·5 to 10·5 inches), and apparently a large number was obtained. If we consider the average size to be 9·5 inches, the difference between this average and that obtained for the southern portion of the North Sea during 1898–1899, viz. 12·5 inches, is again one year's growth.

"The observations are comparatively few in number, it must be admitted, but they point to the conclusion that man's influence may be causing a retrogression in the average size at which the plaice spawn for the first time. This would seem to lead to the further conclusion that the numbers of the species will be maintained at their former level by the earlier reproduction, even if the older and larger fish have been removed by man. This idea has indeed been expressed, though from a different standpoint, but unfortunately nature offers no great compensation, for the large plaice have over ten times more offspring than the small.

"In a former paper the view has been expressed that if we could regard the average size at first maturity as a comparatively fixed point in the life-history of the plaice, we might therefrom, by comparison with the average size of the adults, obtain a measure of the increase or decrease in the numbers of the species, but the considerations presented above show that we can no more rely upon it than upon any other variable and varying stage. One important consequence is that we cannot accept, without repeated investigation, the results obtained in previous years, as a record of ten years ago may no longer hold true.

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* *Eighteenth Rep. S. F. B.*, iii. p. 197.

† J. T. Cunningham, *Journ. M. B. A.*, vol. iv. pp. 17 and 99.

‡ I am indebted to my friend Prof. Ehrenbaum, of Heligoland, for permission to mention these records.

"The plaice on the south-west coast of England have been investigated at various times by Mr. Cunningham, and the results are given in vol. iii. p. 69 *et seq.* of this Journal. One hundred and nine specimens were examined during the winter, *i.e.* during the spawning season, and of these forty-two were males, sixty-seven females. The smallest mature male was 9 inches long, the largest immature 12 inches. The smallest mature female was likewise 9 inches, and the largest immature 14 inches long.

"During the present investigations a considerable number of plaice were examined from all quarters and at all sizes. The spawning months, from November to March, were deliberately chosen, and all doubtful males have been excluded from the list. The following tables show the numbers at the various sizes mentioned:—

TABLE XXX.—1. *Males.*

Length in centimetres	20, 21	22, 23	24, 25	26, 27	28, 29	30, 31	32, 33	34, 35	36, 37	Total.
Immature . .	13	11	17	3	5	2	2	1	0	54
Percentage .	*81*	*61*	*63*	*25*	*14*	*5*	*4*	*2*	—	
Mature . .	3	7	10	9	30	40	55	50	33	237
Percentage .	*19*	*39*	*37*	*75*	*86*	*95*	*96*	*98*	*100*	

2. *Females.*

Length in centimetres	26, 27	28, 29	30, 31	32, 33	34, 35	36, 37	38, 39	40, 41	42, 43	Total.
Immature . .	5	18	22	11	17	11	6	0	1	91
Percentage .	*83*	*86*	*61*	*41*	*39*	*27*	*16*	—	*4*	
Mature . .	1	3	14	16	27	29	32	34	22	178
Percentage .	*17*	*14*	*39*	*59*	*61*	*73*	*84*	*100*	*96*	

"It appears from these tables that the ranges of variation are greater than those detected by Cunningham. The smallest mature males were 21 cm. long ($8\frac{1}{4}$ inches), and a special search would, I think, discover even smaller mature specimens. The largest immature male was 34 cm. ($13\frac{1}{2}$ inches), or 13 cm. longer than the smallest mature. The smallest mature female was 26 cm. ($10\frac{1}{4}$ inches), and the largest immature 42 cm.

(16½ inches). The range of variation is therefore from 13 to 16 cm. (5 to 6 inches). For the North Sea specimens the same range was found to be 12 to 14 cm.

"According to Dr. Fulton,* all plaice probably spawn at the same age, and the difference in size is simply a difference in the rate of growth. I am inclined to think, however, that the range of variation (6 inches) is too great for the difference due to the rate of growth under natural conditions. The fact, also, that the difference in average size at first maturity of the southern and northern North Sea plaice is approximately equal to one year's growth speaks in favour of the same conclusion."

* * * * *

The average size at which each sex matures for the first time being that at which 50 per cent. become mature, it may be concluded from these data that the average size for the females is 31·5 cm. (= 12·5 inches), and for the males about 25 cm. (= 10 inches). Dr. Kyle concludes:—"These values are a little less than those for the plaice of the southern parts of the North Sea. If we assume that the numbers of the males and females are approximately equal, then 28 cm. (11 inches) represents the average size at which all plaice of both sexes become mature for the first time."

SECTION IV.

General Summary and Conclusions.

By

Walter Garstang, M.A., F.Z.S.

The facts and experiments recorded in the preceding sections lead to the following main conclusions:—

(1) Plaice below 8 inches in length are practically confined to the inshore waters of the bays at all seasons of the year. They are especially abundant in Teignmouth Bay and Torbay, where they are caught with the usual trawl-mesh in numbers at least as great as those of all the larger sizes of plaice taken together. In Start Bay, on the other hand, these small plaice are far less numerous than the larger fish, which outnumber them by eighteen to one (Table II., p. 449).

In correlation with these facts the average size of all the plaice caught during 1901–2 was found to be 12·8 inches for Start Bay, 7·8 inches for Torbay, and 7·9 inches for Teignmouth Bay.

The actual percentages of small plaice caught in the bays were—Teignmouth Bay, 60 per cent.; Torbay, 50 per cent.; Start Bay, 4 per cent.

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* *Twentieth Ann. Rep. S. F. B.*, iii. p 359.

(2) On attaining a length of 8 inches the plaice in Teignmouth Bay and Torbay tend to emigrate—in summer into Start Bay, and in winter over the offshore grounds. The special statistics appear to show that about 44 per cent. of the plaice caught offshore by the Brixham "Mumble Bees" are immature fish from 8 to 10 inches in length. These are doubtless derived for the most part from the two bays mentioned, although Sidmouth Bay and Lyme Bay probably contribute. Few of these fishes, however, are derivable from Start Bay; the marking experiments revealed a much slighter tendency for fishes of this size to emigrate from Start Bay than from the other two.

(3) Teignmouth Bay and Torbay are thus essentially nurseries or rearing grounds for the smallest plaice. They furnish the original stock from which Start Bay and the offshore grounds are annually recruited.

Start Bay, on the other hand, is not a nursery for plaice.

(4) Apart from seasonal changes in abundance caused by periodic migrations, the population of flat-fish in the bays is subject to considerable fluctuations from one year to another. These fluctuations are not traceable to the operation of the Committee's bye-laws, since fluctuations in both directions (viz. of increase and of decrease) have taken place at intervals during the period of closure. They appear to be attributable to the effects of good and bad spawning seasons, and especially to the direction of the winds during the period when the eggs and larvæ of the fish are drifting in the water prior to metamorphosis.

(5) The closure of the bays to trawlers appears to be useful only in so far as it protects the plaice from premature destruction. From this point of view the closure of Start Bay is ineffective, since the small fish are present in inappreciable numbers. Even the plaice below 12 inches in length in Start Bay did not amount, in 1901–2, to 30 per cent. of the total, which is considerably less than the percentage landed by the fishermen from the fishing grounds in general during 1902 (44 per cent.).

On the other hand, the closure of Teignmouth Bay and Torbay must be of great value for the upkeep of the fishery, since these bays furnish an important, and probably the chief, source of supply of young plaice for the trawling grounds in general.

(6) The closure of the bays does not protect the spawning fish to an appreciable extent, since the latter spawn mostly offshore.

(7) The closure of Teignmouth Bay (and probably of Torbay) defers the period of capture of a certain number of marketable fish, but does not cause any serious deprivation to the fishermen, since the same fish are available for capture after emigration from the bays when of larger

size and higher value. The marking experiments show that at least 41 per cent. of the marketable plaice marked in Teignmouth Bay were subsequently caught by the fishermen, viz. 31 per cent. during the first year, and 10 per cent. during the second.

On the other hand, the closure of Start Bay appears to deprive the small trawlers of a serious proportion of the large plaice which they would otherwise secure. Only 23½ per cent. of the marked plaice from Start Bay were recovered, viz. 21½ per cent. in the first year and 2 per cent. in the second. The difference between the percentages in the two experiments appears to indicate that about 10 per cent. of the large plaice in Start Bay annually migrate outside the area of the Mumble Bees altogether. It is impossible at present to say whether this migration materially affects the upkeep of the trawling grounds in the Channel, to which it undoubtedly contributes; but, regarding the matter merely from the standpoint of the Brixham fishery, it appears fairly certain that the closure of Start Bay altogether deprives the small trawlers of a considerable number of large plaice, against the capture of which no biological objections can be urged.

(8) In view of the facts ascertained by these investigations, and having regard to the permanent maintenance of the fishery, it would appear to be highly inadvisable to rescind the regulation which prohibits trawling in Teignmouth Bay and Torbay. On the other hand there are no biological reasons against the reopening of Start Bay, either as a whole or in its northern part alone, as suggested by Mr. Holt in his previous report.

In this connection it cannot be overlooked that the natural migrations of the fishes determine to a large extent the areas in a particular district which it is profitable or unprofitable for the trawlers to work over. There is no doubt that during the autumn months the plaice are concentrated in the bays, especially in Start Bay. At this season of the year the trawlers are limited by the closure of the bays to the soles and whiting on the offshore grounds (cf. Table A).

Table A.

Weekly number of Plaice, Soles, and Whiting captured by "Mumble Bees" during One Year (February 1st, 1902, to January 31st, 1903), with proportion of Small to Large.

	Plaice.					Soles.	Whiting.				
1902.	No. of Trunks.	No. of Fish.	No. of Baskets.	No. of Fish.	Proportion %.	Pairs of.	No. of Trunks.	No. of Fish (Large).	No. of Fish (Medium).	No. of Baskets.	No. of Fish (Small)
Feb. 3–8	38	3,420	50	1,250	—	525	93	1,209	7,440	465	33,015
,, 10–15	81	7,290	56	1,400	—	1,560	276	3,588	22,080	880	79,980
,, 17–22	79	7,110	24	600	—	1,040	240	3,120	19,200	780	70,080
,, 24–Mar. 1	53	4,770	43	1,075	—	648	216	2,808	17,280	455	54,180
Total.	251	22,590	173	4,325	19	3,773	825	10,725	66,000	2,580	237,255
March 3–8	100	9,000	110	2,750	—	—	60	780	4,800	200	17,700
,, 10–15	16	1,440	—	—	—	—	20	260	1,600	100	7,100
,, 17–22	40	3,600	12	300	—	—	50	650	4,000	150	14,150
,, 24–29	74	6,660	53	1,325	—	—	14	182	1,120	160	8,210
Total.	230	20,700	175	4,375	21	—	144	1,872	11,520	610	47,160
Mar. 31–Ap. 5	98	8,820	76	1,900	—	—	—	—	—	200	7,200
April 7–12	135	12,150	250	6,250	—	—	—	—	—	22	792
,, 14–19	56	5,040	90	2,250	—	—	—	—	—	—	—
,, 21–26	65	5,850	126	3,150	—	—	—	—	—	—	—
,, 28–May 3	200	18,000	250	6,250	—	350	19	247	1,520	65	5,665
Total.	554	49,860	792	19,800	40	350	19	247	1,520	287	13,657
May 5–10	50	4,500	120	3,000	—	390	28	364	2,240	115	9,040
,, 12–17	32	2,880	30	750	—	675	28	364	2,240	100	8,500
,, 19–24	25	2,250	24	600	—	630	15	195	1,200	45	4,245
,, 26–31	31	2,790	—	—	—	650	39	507	3,120	130	11,505
Total.	138	12,420	174	4,350	35	2,345	110	1,430	8,800	390	33,290
June 2–7	72	6,480	70	1,750	—	1,740	98	1,274	7,840	430	32,630
,, 9–14	50	4,500	110	2,750	—	864	114	1,482	9,120	378	33,558
,, 16–21	25	2,250	134	3,350	—	840	102	1,326	8,160	600	39,450
,, 23–28	17	1,530	40	1,000	—	—	75	975	6,000	500	31,125
Total.	164	14,760	354	8,850	60	3,444	389	5,057	31,120	1,908	136,763
June 30–July 5	16	1,440	18	450	—	300	21	273	1,680	150	9,075
July 7–12	40	3,600	50	1,250	—	1,139	135	1,755	10,800	750	50,625
,, 14–19	23	2,070	88	2,200	—	1,275	69	897	5,520	630	34,755
,, 21–26	24	2,160	80	2,000	—	1,200	228	2,964	18,240	1,470	92,820
,, 28–Aug. 2	16	1,440	150	3,750	—	1,800	320	4,160	25,600	1,500	110,000
Total.	119	10,710	386	9,650	90	5,714	773	10,049	61,840	4,500	297,275
Aug. 4–9	5	450	182	4,550	—	1,425	128	1,664	10,240	1,310	69,560
,, 11–16	10	900	104	2,600	—	1,150	157	2,041	12,560	1,450	79,675
,, 18–23	8	720	88	2,200	—	1,800	240	3,120	19,200	1,400	92,400
,, 25–30	2	180	52	1,300	—	1,080	103	1,339	8,240	1,360	66,985
Total.	25	2,250	426	10,650	473	5,455	628	8,164	50,240	5,520	308,620

TABLE A—*continued.*

	PLAICE.					SOLES.	WHITING.				
1902.	No. of Trunks.	No. of Fish.	No. of Baskets.	No. of Fish.	Proportion %.	Pairs of.	No. of Trunks.	No. of Fish (Large).	No. of Fish (Medium).	No. of Baskets.	No. of Fish (Small).
Sept. 1–6 .	1	90	50	1,250	—	1,430	123	1,599	9,840	1,400	71,925
,, 8–13 .	2	180	72	1,800	—	2,310	228	2,964	18,240	1,900	108,300
,, 15–20 .	3	270	80	2,000	—	2,145	239	3,107	19,120	1,410	92,585
,, 22–27 .	8	720	60	1,500	—	1,425	180	2,340	14,400	1,410	82,260
Total . .	14	1,260	262	6,550	520	7,310	770	10,010	61,600	6,120	355,070
Sept. 29–Oct. 4	2	180	50	1,250	—	2,316	295	3,835	23,600	2,700	148,825
Oct. 6–11 .	1	90	50	1,250	—	1,000	197	2,561	15,760	1,420	85,595
,, 13–18 .	2	180	60	1,500	—	1,215	270	3,510	21,600	1,420	98,370
,, 20–25 .	—	—	48	1,200	—	1,380	55	715	4,400	740	36,265
,, 27–Nov. 1	—	—	64	1,600	—	2,320	126	1,638	10,080	1,550	77,850
Total . .	5	450	272	6,800	1,511	8,231	943	12,259	75,440	7,830	446,905
Nov. 3–8 .	—	—	76	1,900	—	1,000	248	3,224	19,840	2,300	126,200
,, 10–15 .	3	270	180	4,500	—	2,115	410	5,330	32,800	2,850	174,350
,, 17–22 .	1	90	18	450	—	600	255	3,315	20,400	1,550	100,425
,, 24–29 .	—	—	60	1,500	—	360	55	715	4,400	550	29,425
Total . .	4	360	334	8,350	2,319	4,075	968	12,584	77,440	7,250	430,400
Dec. 1–6 .	17	1,530	96	2,400	—	735	306	3,978	24,480	1,925	122,850
,, 8–13 .	1	90	70	1,750	—	585	298	3,874	23,840	2,525	143,050
,, 15–20 .	10	900	62	1,550	—	1,250	480	6,240	38,400	3,500	210,000
,, 22–31 .	2	180	40	1,000	—	150	245	3,185	19,600	1,810	108,035
Total . .	30	2,700	268	6,700	248	2,720	1,329	17,277	106,320	9,760	583,935
1903.											
Jan. 1–8 .	10	900	16	400	—	530	191	2,483	15,280	1,220	77,345
,, 5–10 .	31	2,790	94	2,350	—	—	345	4,485	27,600	2,120	136,695
,, 12–17 .	41	3,690	60	1,500	—	1,415	210	2,730	16,800	1,150	78,150
,, 19–24 .	4	360	134	3,350	—	1,619	252	3,276	20,160	1,320	91,620
,, 26–31 .	2	180	106	2,650	—	1,110	129	1,677	10,320	840	52,815
Total . .	88	7,920	410	10,250	129	4,674	1,127	14,651	90,160	6,650	436,625

TABLE B.

LIST OF TRAWLING STATIONS.

START BAY.

No. of Haul.	Date.	Locality and Course.	Station.	Hour Trawl Shot.	Duration of Haul. h. m.	Remarks.
	1901.					
1	July 30	Start Bay (inshore); two hauls combined.	II.	8.45 a.m.	2 35	18 Plaice marked (experimental).
2	,, 30	Start Bay (central part) . .	I.	1 p.m.	2 0	10 Plaice marked (experimental).
3	Aug. 7	,, ,, . .	I.	11.30 a.m.	2 0	12 Plaice marked (experimental).
4	,, 8	,, N.E. part; depth 8–12 fms.	I.	Forenoon.	1 10	
5	,, 9	Haul close inshore from Torcross to Street Gate in 5–6 fms.	II.	—	1 10	2 Plaice marked (experimental).
6	Sept. 6	From inside Skerries Buoy to Hallsands.	III.	1 p.m.	2 0	
7	,, 7	Shot farther to S.W. than on previous day, and continued farther down to off Hallsands, 1 mile from Start Point.	III.	6.10 a.m.	2 0	20 Plaice marked (experimental).
8	,, 7	From beginning of measured line above Torcross towards Street Head; direction N.E., then E.N.E., past Earlstone, towards East Blackstone until off Warren Point.	II.	9.50 a.m.	2 0	
9	,, 9	Start Bay (centre of bay) .	I.	6.35 a.m.	1 55	
10	,, 9	,, (inshore); stopped off Street Point, trawling against tide.	II.	9.40 a.m.	2 0	
11	,, 9	3 miles off Torcross, heading N. in thick fog, hauled up just above Torcross, about a mile from shore.	I.	5.30 p.m.	1 5	
12	,, 10	Round S.W. corner of Skerries	III.	6 a.m.	2 0	
13	,, 10	Down centre of Start Bay, from off Royal Sands Hotel, towards Start Point, ending off Hallsands.	I.	10.25 a.m.	1 15	
14	Oct. 1	From near Skerries Buoy towards Start Point.	III.	3.20 p.m.	1 10	
15	,, 1	Off Torcross towards Blackpool	II.	5.40 p.m.	2 0	
16	,, 2	Began off Dartmouth Fairway, Southern Point.	I.	Noon.	2 15	40 Plaice marked.
17	,, 3	Start Bay (central part) . .	I.	4 a.m.	1 30	
18	,, 3	,, ,, . .	I.	1.15 p.m.	2 0	38 Plaice marked.
19	,, 3	Inshore, along Slapton Sands, 7½ fms. and 8 later.	II.	4.30 p.m.	1 0	6 Plaice marked.
20	,, 4	Start Bay (central part) . .	I.	12.40 p.m.	1 10	15 Plaice marked.
21	,, 11	,, ,, . .	I.	1.50 p.m.	2 0	6 Plaice marked.
22	Nov. 6	,, ,, . .	I.	7.30 a.m.	2 0	
23	,, 6	On the Skerries . . .	III.	10.50 a.m.	1 0	
24	,, 7	Start Bay (central part) . .	I.	1.5 p.m.	3 0	11 Plaice marked.
25	,, 8	Inshore from Straight Point, ½ mile from shore, hence out off Gully, keeping house at foot in line with two trees on top until Blackpool and Cod Rock in line, then to Cod.	II.	12.30 p.m.	1 50	26 Plaice marked.

TABLE B—*continued.*

START BAY—*continued.*

No. of Haul.	Date.	Locality and Course.	Station.	Hour Trawl Shot.	Duration of Haul. h. m.	Remarks.
	1901.					
26	Nov. 9	Northern portion of bay . .	I.	3.45 a.m.	3 0	
27	,, 9	From Torcross to Straight Point, then out and turned back towards Torcross.	II.	8.15 a.m.	2 5	30 Plaice marked.
28	,, 9	Out round Oyster Bank to off Beesands.	II.	11.50 a.m.	1 0	
29	,, 15	Start Bay (centre) . . .	I.	2.10 p.m.	2 30	
30	,, 16	Start Point to Roughs . .	IIA.	7.25 a.m.	0 40	
31	Dec. 17	Start Bay (centre) . . .	I.	8 a.m.	3 0	
32	,, 17	Along inside Skerries (1 h. 30 m.), and again as before, but towing to Start Point (1 h. 40 m.); two hauls combined.	III.	12.20 p.m.	3 10	Trawl entangled in one or two crablines at S.W. corner during second haul.
33	,, 17	Start Bay (centre) . . .	I.	Night.	3 0	
34	,, 18	Northern portion, from Blackpool Sands to Skerries Buoy, in again to Slapton Sands, then out.	I.	1.40 p.m.	3 0	
35	,, 18	Northern portion of bay, starting from off Mewstone, trawling south to 20 fms., then in towards Blackpool Sands, then out to Skerries Buoy, returning over same course.	I.	7.10 p.m.	3 0	
36	,, 19	Northern portion, from Torcross, close inshore towards Mewstone, then off Blackpool towards eastwards to ½ mile from Buoy, then west to Torcross and out again.	I.	2.30 p.m.	3 0	
37	,, 19	Start Bay, all over Bay . .	I.	9.30 p.m.	4 0	Dabs and Gurnards not measured.
	1902.					
38	Jan. 21	N.E. portion, from Blackpool towards Bell Buoy, then down centre.	I.	5.15 p.m.	1 45	
39	,, 22	Along inside Skerries . .	III.	2.15 p.m.	1 30	
40	,, 24	From off Blackpool to off Hallsands, and return.	I.	2 p.m.	3 30	
41	,, 25	Deep water from Mewstone to Skerries Buoy.	I.	—	1 0	
42	Feb. 4	N.E. portion, Bell Buoy to Mewstone.	I.	12.45 p.m.	1 45	
43	,, 5	N.E. corner, from Mewstone to Bell Buoy.	I.	10.15 a.m.	1 15	
44	Apl. 8	Start Bay, N.E. portion . .	I.	6.25 p.m.	0 40	
45	,, 14	Mewstone to Skerries Buoy .	I.	5.30 p.m.	1 0	
46	,, 15	On the Skerries . . .	III.	7.50 a.m.	1 0	
47	,, 15	Start Bay (centre) . . .	I.	9.30 a.m.	2 30	
48	,, 15	Inside Skerries . . .	III.	2.50 p.m.	2 0	
49	May 22	Start Bay, N.E. corner . .	I.	8.25 a.m.	2 0	
50	,, 22	,, (centre) . . .	I.	11.10 a.m.	2 0	
51	,, 22	N.E. corner, Blackpool to Buoy, then to Fairway.	I.	2.45 p.m.	3 0	
52	,, 23	Start Bay, N.E. corner . .	I.	6.20 a.m.	1 45	
53	,, 24	,, (centre) . . .	I.	10.5 a.m.	2 30	
54	,, 24	Inshore, along Slapton Sands to off Oyster Bank.	II.	1.45 p.m.	1 0	

TABLE B—*continued.*

START BAY—*continued.*

No. of Haul.	Date.	Locality and Course.	Station.	Hour Trawl Shot.	Duration of Haul. h. m.	Remarks.
	1902.					
55	May 29	Start Bay, N.E. corner . .	I.	Night.	6 0	Plaice alone measured.
56	June 19	,, ,, . .	I.	11.30 a.m.	1 0	
57	,, 26	,, ,, . .	I.	4.15 p.m.	1 0	
58	,, 27	,, (centre) . .	I.	5.50 a.m.	1 30	
59	,, 30	,, ,, Two hauls combined.	I.	6.55 p.m.	3 0	
60	July 21	Mewstone on Downend; shot rather outside marks, towed in towards Slapton Ley till marks were right, towed towards Redlap, hauled 1 mile off Blackpool.	I.	3.10 p.m.	2 25	Homelyn and Blonde Rays not distinguished.
61	,, 22	Shot off E. end of Slapton Sands, hauled off Torcross.	II.	10.10 a.m.	0 50	
62	,, 22	Shot off Fairway Buoy, Dartmouth, hauled off Torcross.	I.	12.10 p.m.	1 30	Homelyn and Blonde Rays not distinguished.
63	,, 25	Centre of bay, Downend on Mewstone; towed towards Blackpool Sands, then out again towards 2 m. S.W. of Mewstone	I.	8.25 a.m.	1 45	
64	Aug. 25	Start Bay, N.E. corner . .	I.	8.30 p.m.	1 0	
65	,, 26	,, (centre) . . .	I.	11.45 a.m.	3 0	
66	,, 27	Along Slapton Sands, starting from Street Point.	II.	3.55 p.m.	1 15	
67	,, 28	Inshore, Slapton Sands, hauled up before passing Street Point.	II.	11.55 a.m.	0 30	
68	,, 28	Start Bay, N.E. corner . .	I.	1 p.m.	2 0	
69	,, 28	,, (centre) . . .	I.	3.40 p.m.	3 0	Plaice alone measured.
70	Oct. 6	,, (N.E. part) . .	I.	9 a.m.	1 30	

TABLE B—*continued.*

TORBAY.

No. of Haul.	Date.	Locality and Course.	Station.	Hour Trawl Shot.	Duration of Haul. h. m.	Remarks.
	1901.					
1	July 31	Torbay, inshore . . .	IV.	10.40 a.m.	1 40	
2	,, 31	,, ...	VI.	4 p.m.	1 10	8 Plaice marked.
3	Aug. 1	,, ...	V.	8.55 a.m.	1 5	16 Plaice marked.
4	Sept. 11	,, hauled up beyond breakwater, Brixham.	IV.	11.35 a.m.	1 30	
5	,, 11	Torbay, from Berry Head to Orestone.	VI.	1.45 p.m.	1 30	
6	,, 12	From Goodrington Sands, along inside foul ground, ½ to ¾ mile from shore, as far as Fishcombe Cove.	IVA.	—	1 0	
7	,, 12	Diagonally across bay, from Berry Head to Torquay, ½ mile from shore, about ½ mile out from Torquay.	V.	3.40 p.m.	1 0	
8	Oct. 7	Torbay	IV.	12.35 p.m.	1 15	
9	,, 7	,, inside "Rough" . .	IVA.	2.45 p.m.	1 0	
10	,, 10	From Paignton Pier towards Brixham, inside Rough.	IVA.	7.15 a.m.	1 0	
11	,, 10	Torbay, trawling towards Brixham.	V.	9.15 a.m.	1 15	18 Plaice marked.
12	,, 11	Torbay, inside Rough . .	IVA.	—	1 0	
13	Nov. 11	Ilsham to Brixham . . .	V.	7.55 a.m.	1 0	
14	,, 12	Inside Rough	IVA.	8.25 a.m.	0 50	
15	,, 14	Hope's Nose to Berry Head, Torbay.	VI.	1.50 p.m.	1 0	7 Plaice marked.
16	,, 15	Torbay	V.	5.40 a.m.	1 0	
17	,, 15	Inside Rough, hauled off Paignton Pier.	IVA.	9 a.m.	1 30	
18	Dec. 12	Torbay	IV.	1.45 p.m.	2 0	
19	,, 14	Ilsham to Breakwater . .	V.	9.30 a.m.	0 45	
	1902.					
20	Jan. 28	Torbay	IV.	4.40 p.m.	1 0	
21	,, 29	,, ...	VI.	3.30 p.m.	0 45	
22	April 17	Inside Rough	IVA.	7.55 a.m.	1 30	
23	,, 17	Torbay	V.	10.55 a.m.	1 15	
24	,, 19	,, ...	VI.	9.30 a.m.	1 0	
25	May 26	,, inside Rough . .	IVA.	5.5 p.m.	0 40	
26	,, 26	,, ...	IV.	6.30 p.m.	1 0	
27	July 2	,, inside Rough . .	IVA.	2 p.m.	1 0	
28	,, 2	,, ...	IV.	4.35 p.m.	0 30	
29	,, 3	,, ...	V.	11.30 a.m.	1 0	
30	,, 24	Shot off Brixham, towed towards Kingston Valley.	V.	10.40 a.m.	1 30	
31	,, 24	Inside Rough, towed towards Goodrington Head.	IVA.	12.45 p.m.	1 0	
32	,, 24	Orestone to Berry Head . .	VI.	3.50 p.m.	1 0	
33	Sept. 1	Torbay, Ilsham to Breakwater .	V.	9.15 a.m.	0 45	
34	,, 1	,, Torquay to Paignton .	IV.	11 a.m.	1 0	
35	,, 1	,, inside Ledge . .	IVA.	1.15 p.m.	1 0	
36	,, 4	,, Berry Head to Orestone	VI.	4.25 p.m.	1 0	

TABLE B—*continued.*

TEIGNMOUTH BAY.

No. of Haul.	Date.	Locality and Course.	Station.	Hour Trawl Shot.	Duration of Haul. h. m.	Remarks.
	1901.					
1	Aug. 1	Teignmouth Bay . . .	VII.	11.20 a.m.	1 0	15 Plaice marked.
2	,, 1	,, ,, . . .	IX.	2 p.m.	2 0	
3	,, 2	,, ,, . . .	VIII.	9.50 a.m.	1 50	7 Plaice marked.
4	Sept. 13	From Anstis Cove to the Ness (in about 8 fms.).	VII.	8.10 a.m.	1 30	
5	,, 13	From off the Ness (4–5 fms.), along shore to Babbacombe.	VII.	10.50 a.m.	1 30	
6	,, 13	Off Teignmouth Bar, ½ mile along shore N.E. direction, in 5–7 fms., hauled off Dawlish and from off Langstone Point along shore in 5 fms., ¾ mile from Fairway Buoy.	VIII.	1.30 p.m.	2 35	
7	Oct. 9	Teignmouth Bay . . .	VII.	10.50 a.m.	2 15	53 Plaice marked. Rays not measured.
8	,, 9	,, ,, towards Pole Sands.	VIII.	2.15 p.m.	1 15	Rays not measured.
9	,, 11	Teignmouth Bay . . .	VII.	7.15 a.m.	1 15	Rays not measured.
10	Nov. 11	,, ,, off Babbacombe to the Ness.	VII.	4.15 p.m.	1 5	
11	,, 13	Teignmouth, after a S.W. gale on previous day.	VII.	9.50 a.m.	1 30	19 Plaice marked.*
12	,, 13	Along Pole Sands (in 5 fms. water)	VIII.	12.50 p.m.	2 0	2 Plaice marked.
13	,, 14	From off Dawlish, along Pole Sands.	VIII.	4.40 a.m.	2 0	Rays not measured.
14	Dec. 11	Babbacombe to the Ness and back again.	VII.	11.25 a.m.	3 30	
15	,, 13	Pole Sands, from Fairway Buoy to Langstone Point; course irregular, but mostly in 5 fms.	VIII.	12.40 p.m.	1 0	
	1902.					
16	Jan. 28	Teignmouth Bay . . .	VII.	7.15 a.m.	1 30	
17	,, 28	,, ,, Pole Sands .	VIII.	10.20 a.m.	0 45	
18	April 17	,, ,, ...	VII.	3 p.m.	1 30	
19	,, 17	,, ,, on the Ledge off Teignmouth on line Exmouth to Berry Head.	IX.	5.15 p.m.	1 0	
20	,, 18	Teignmouth towards Dawlish, then to Fairway Buoy . .	VIII.	1.45 p.m.	3 0	Net full of weed.
21	,, 18	Teignmouth	VII.	9.30 p.m.	2 0	
22	May 27	Teignmouth Bay . . .	VII.	9.45 a.m.	1 45	Trawl full of *ulva*.
23	,, 27	Pole Sands, and . . Pole Sands, outer part . (two short hauls combined)	VIII.	1.30 p.m.	1 45	Not much weed.
24	,, 27	From Pole Sands towards Hope's Nose, 2 miles from shore.	IX.	4.25 p.m.	2 0	
25	,, 28	Inside Ledge	IX.	11.40 a.m.	1 30	
26	July 2	On line Hope's Nose to Fairway Buoy, 2 miles off Teignmouth	IX.	5.40 p.m.	1 30	
27	,, 2	Pole Sands	VIII.	8.30 p.m.	1 0	
28	,, 5	Teignmouth Bay . . .	VII.	6.30 a.m.	0 45	
29	,, 5	,, ,, inside Ledge .	IX.	7.45 a.m.	1 0	
30	,, 23	Shot in 5 fms. just to N.E. of Parson and Clerk rocks; towed towards Fairway Buoy, Exmouth, and hauled ½ mile off.	VIII.	9.30 a.m.	1 40	
31	Sept. 4	Teignmouth Bay . . .	VII.	6.30 p.m.	0 45	
32	,, 4	Dawlish, along Pole Sands .	VIII.	8.15 p.m.	1 30	Rays not measured.

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* Haul 11.—The entries in the log-books render the allotment of 14 of these marked fish open to slight doubt.

TABLE C.

Records of Hauls of the Trawl made with s.s. "Oithona" in 1901–1902.

START BAY.

	STATION.	II.	I.	I.	I.	II.	III.	III.	II.	I.	II.	I.	III.	I.	III.
	DATE.	1901. July 30.	July 30.	Aug. 7.	Aug. 8.	Aug. 9.	Sept. 6.	Sept. 7.	Sept. 7.	Sept. 9.	Sept. 9.	Sept. 9.	Sept. 10.	Sept. 10.	Oct. 1.
	HAUL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	DURATION OF HAUL.	2h. 35m.	2 hours.	2 hours.	1h. 10m.	1h. 10m.	2 hours.	2 hours.	2 hours.	1h. 55m.	2 hours.	1h. 5m.	2 hours.	1h. 15m.	1h. 10m.
1	Dab (below 8 in.)	24	8	5	14	—	1	1	39	—	7	1	—	—	—
	P. limanda, L. (8 in. & above)	21	4	3	14	—	43	8	45	9	39	24	8	6	1
2	Flounder (below 8 in.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	P. flesus, L. (8 in. & above)	—	—	—	—	3	—	—	—	—	—	—	—	—	—
3	Sole (below 8 in.)	1	1	—	—	—	—	—	—	—	—	—	—	—	—
	S. vulgaris, Quen. (8 in. & above)	9	6	1	2	1	1	—	2	—	2	3	—	2	—
4	Sand Sole (*S. lascaris*, Risso.)	—	1	—	—	—	4	4	—	4	—	—	14	2	—
5	Thickback (*S. variegata*, Flem.)	—	—	—	—	—	1	—	—	—	—	—	—	—	—
6	Solenette (*S. lutea*, Bon.)	—	4	10	7	—	—	—	2	—	—	3	—	—	—
7	Lemon Sole (*P. microcephalus*, Don.)	—	—	—	—	—	—	—	—	—	—	1	—	—	—
8	Plaice (below 8 in.)	19	5	2	1	—	—	—	11	—	2	—	—	—	—
	P. platessa, L. (8 in. & above)	39	16	20	24	5	39	72	22	26	57	30	30	24	17
9	Turbot (below 10 in.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R. maximus, Kl. (10 in. & above)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	Brill (below 10 in.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R. lævis, Kl. (10 in. & above)	—	—	—	—	—	2	18	1	2	—	—	7	—	6
11	Whiting (below 8 in.)	1	—	—	—	—	—	—	—	—	—	—	—	—	—
	G. merlangus, L. (8 in. & above)	—	—	—	—	—	1	—	—	—	—	—	—	—	—
12	Bib (*G. luscus*, L.)	—	—	—	—	7	—	—	—	—	1	—	—	—	—
13	Poor Cod (*G. minutus*, L.)	—	—	—	—	2	—	—	—	—	—	—	—	—	—
14	Grey Gurnard (below 8 in.)	49	21	6	29	—	3	—	6	4	9	—	—	2	—
	T. gurnardus, L. (8 in. & above)	3	3	—	—	2	12	4	10	4	4	—	4	—	2
15	Tub (*T. lucerna*, Will.)	16	—	2	6	1	1	—	10	—	7	5	—	1	—
16	Red Gurnard (*T. pini*, Bl.)	—	—	6	1	—	1	21	—	3	—	—	3	—	12
17	Streaked Gurnard (*T. lineata*, L.)	—	—	1	2	—	1	—	—	—	—	—	—	—	—
18	Dory (below 8 in.)	2	3	1	1	—	1	1	—	—	1	—	3	—	—
	Z. faber, L. (8 in. & above)	—	—	—	—	—	2	5	3	3	6	2	1	—	1
19	Mullet (below 8 in.)	—	—	—	1	—	—	1	—	—	—	—	—	—	—
	M. surmuletus, L. (8 in. & above)	—	—	—	—	—	—	1	—	—	—	—	—	—	—
20	Bream (*P. centrodontus*, C. et V.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	Dragonet (*C. lyra*, L.)	24	6	57	65	3	6	3	21	6	—	—	6	6	—
22	Weever (*T. draco*, L.)	—	—	—	2	—	4	8	3	10	8	6	5	1	1
23	Thornback (below 12 in.)	40	16	1	—	—	—	—	2	—	—	—	—	—	—
	R. clavata, L. (12 in. & above)	4	1	—	—	—	—	—	—	—	—	—	—	—	—
24	Homelyn (below 12 in.)	2	—	—	1	—	7	1	3	7	6	5	—	—	—
	R. maculata, Mon. (12 in. & above)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	Blonde (below 12 in.)	—	—	—	—	—	22	22	3	35	—	1	98	6	2
	R. blanda, Holt (12 in. & above)	—	—	—	—	—	15	75	—	44	—	—	33	2	11
26	Painted Ray (below 12 in.)	—	—	—	—	—	4	—	—	—	1	6	—	—	—
	R. microcellata, Mon. (12 in. & above)	—	—	—	—	—	3	—	1	—	—	2	—	—	—
27	*S. canicula*, Cuv.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	*Acanthias vulgaris*, Risso.	1	1	—	—	—	—	—	4	—	2	—	—	—	1
29	Buffoon (*R. squatina*, Gün.)	1	1	1	—	—	—	—	3	—	—	3	—	—	—
30	Scaldback (*A. laterna*, Rond.)	6	12	13	37	—	10	2	3	1	1	7	3	—	—
31	Cod (*G. morrhua*, L.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32	White Skate (*R. alba*, Lac.)	—	—	—	—	—	—	—	—	—	1	—	—	—	—
33	*Agonus cataphractus*, Bl.	—	—	—	—	—	—	—	—	—	1	—	—	—	—
34	*Conger vulgaris*, Cuv.	—	—	—	—	—	—	—	—	—	—	—	—	—	—

	II.	I.	I.	I.	II.	I.	I.	I.	III.	I.	II.	I.	II.	II.	I.	IIA.	I.	III.	I.	I.	I.	I.	I.
	Oct. 1.	Oct. 2.	Oct. 3.	Oct. 3.	Oct. 3.	Oct. 4.	Oct. 11.	Nov. 6.	Nov. 6.	Nov. 7.	Nov. 8.	Nov. 9.	Nov. 9.	Nov. 9.	Nov. 15.	Nov. 16.	Dec. 17.	Dec. 17.	Dec. 17.	Dec. 18.	Dec. 18.	Dec. 19.	Dec. 19.
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	2 hours.	2h. 15m.	1h. 30m.	2 hours.	1 hour.	1h. 10m.	2 hours.	2 hours.	1 hour.	3 hours.	1h. 50m.	3 hours.	2h. 5m.	1 hour.	2h. 30m.	40 min.	3 hours.	3h. 10m.	3 hours.	3 hours.	3 hours.	3 hours.	4 hours.
1	10	17	3	18	—	6	8	11	—	7	4	21	2	—	1	—	3	—	—	2	—	—	12
	37	121	44	103	17	47	54	63	6	32	20	51	30	23	11	8	22	5	7	5	40	5	
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	3
	—	1	3	—	—	—	2	—	—	2	4	5	5	—	1	1	4	—	5	—	1	—	
4	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	2	—
5	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	1	—	—	—	1	—	—	3	2	2	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
8	—	2	1	1	—	—	2	—	—	—	2	—	—	—	1	—	1	—	1	—	—	—	2
	20	124	70	89	14	78	16	69	17	40	29	66	64	43	42	47	29	30	30	22	22	17	56
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	1	—	2	—	1	1	—	—	—	—	—	—	—	—	2	—
10	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—
	—	—	—	—	—	—	1	—	10	—	—	—	—	1	—	1	—	13	3	2	2	—	—
11	1	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	7	—	—	—	6	—	2
	—	—	—	1	—	—	2	4	—	2	1	—	—	—	3	—	5	—	—	1	22	1	
12	—	—	—	—	1	—	—	—	—	—	76	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	10	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
14	40	41	2	29	7	22	36	37	1	8	23	20	29	11	5	—	20	—	—	7	4	1	20
	16	16	3	35	15	36	26	59	2	27	11	9	25	13	33	3	45	—	—	12	32	10	
15	2	2	2	2	1	4	5	6	—	2	6	3	2	1	1	—	3	—	—	—	—	—	—
16	—	1	1	—	—	—	—	—	3	—	—	—	—	—	—	—	—	2	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	2	—	1	1	—	1	2	—	—	1	1	—	—	—	—	1	—	—	—	—	—	—
	2	8	—	5	9	6	3	9	12	10	5	—	4	1	14	1	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
21	7	12	12	12	—	20	many	40	12	many	12	20	—	12	—	2	12	—	—	—	6	6	—
22	—	10	3	4	—	14	2	1	3	1	—	—	—	3	—	—	1	2	—	—	2	5	—
23	—	—	—	—	3	—	3	—	—	—	3	—	—	—	—	4	1	1	?	—	—	—	—
	—	—	—	—	1	—	—	—	—	—	1	—	—	1	2	3	—	—		—	—	—	—
24	—	—	7	1	—	—	3	—	—	3	2	1	3	1	—	5	—	—	?	—	—	—	—
	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—
25	—	—	—	—	—	1	—	—	17	—	—	—	—	—	—	—	—	19	?	—	12	8	—
	—	—	5	—	—	—	—	—	20	—	—	—	—	—	—	1	—	18		6	1	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	2	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	1	—	—	—	2	—	1	3	—	—	—	2	—	—
27	1	3	—	—	1	—	1	1	—	5	—	—	—	—	—	—	1	—	—	—	—	—	—
28	60	20	—	—	2	5	2	40	?	very many	1	—	—	—	20	—	12	—	—	—	2	—	—
29	—	2	—	—	4	—	—	1	1	—	1	—	—	1	—	1	—	—	—	—	—	—	—
30	3	13	3	3	1	5	few	5	1	5	5	5	—	5	—	—	—	—	—	—	3	—	—
31	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
32	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
33	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	1	—	—

TABLE C—*continued.*

START BAY—*continued.*

	STATION.	I.	III.	I.	I.	I.	I.	I.	I.	III.	I.	III.
	DATE.	1902. Jan. 21.	Jan. 22.	Jan. 24.	Jan. 25.	Feb. 4.	Feb. 5.	April 8.	April 14.	April 15.	April 15.	April 15.
	HAUL.	38	39	40	41	42	43	44	45	46	47	48
	DURATION OF HAUL.	1h. 45m.	1h. 30m.	3h. 30m.	1 hour.	1h. 45m.	1h. 15m.	40 min.	1 hour.	1 hour.	2h. 30m.	2 hours.
1	Dab (below 8 in.)	3	—	10	5	10	—	—	3	—	5	—
	P. limanda, L. (8 in. & above)	6	3	14	16	5	5	1	2	—	4	—
2	Flounder (below 8 in.)	—	—	—	—	—	—	—	—	—	—	—
	P. flesus, L. (8 in. & above)	—	—	2	1	—	—	—	—	—	—	—
3	Sole (below 8 in.)	—	—	—	—	—	—	—	—	—	—	—
	S. vulgaris, Quen. (8 in. & above)	1	—	1	1	1	3	—	—	—	—	—
4	Sand Sole (*S. lascaris*, Risso.)	—	1	—	—	—	—	—	—	—	—	—
5	Thickback (*S. variegata*, Flem.)	2	—	—	—	—	—	—	—	—	—	—
6	Solenette (*S. lutea*, Bon.)	—	—	—	—	—	—	—	—	—	—	—
7	Lemon Sole (*P. microcephalus*, Don.)	—	—	—	—	—	—	—	—	—	—	—
8	Plaice (below 8 in.)	—	—	3	1	7	1	2	1	—	3	7
	P. platessa, L. (8 in. & above)	3	2	33	17	31	17	1	16	3	33	9
9	Turbot (below 10 in.)	—	—	—	—	—	—	—	—	—	—	—
	R. maximus, Kl. (10 in. & above)	—	—	—	—	—	1	—	—	—	—	—
10	Brill (below 10 in.)	—	—	—	—	—	—	—	—	—	—	—
	R. lævis, Kl. (10 in. & above)	2	9	2	—	1	—	—	—	—	—	2
11	Whiting (below 8 in.)	—	—	—	—	4	—	—	—	—	—	—
	G. merlangus, L. (8 in. & above)	2	—	9	10	1	1	—	—	—	—	—
12	Bib (*G. luscus*, L.)	—	—	—	—	5	—	—	—	—	—	—
13	Poor Cod (*G. minutus*, L.)	—	—	—	—	—	—	—	—	—	—	—
14	Grey Gurnard (below 8 in.)	—	—	7	6	1	—	—	—	—	1	—
	T. gurnardus, L (8 in. & above)	4	6	17	15	—	—	—	—	—	—	—
15	Tub (*T. lucerna*, Will.)	1	—	—	1	2	—	—	—	—	—	—
16	Red Gurnard (*T. pini*, Bl.)	—	—	—	—	—	—	—	—	—	—	—
17	Streaked Gurnard (*T. lineata*, L.)	—	—	—	—	—	—	—	—	—	—	—
18	Dory (below 8 in.)	—	—	—	—	—	—	—	—	—	—	—
	Z. faber, L. (8 in. & above)	—	—	1	—	—	—	—	—	—	—	—
19	Mullet (below 8 in.)	1	—	1	2	—	—	—	—	—	—	—
	M. surmuletus, L. (8 in. & above)	—	—	—	—	—	—	—	—	—	—	—
20	Bream (*P. centrodontus*, C. et V.)	—	—	—	—	—	—	—	—	—	—	—
21	Dragonet (*C. lyra*, L.)	—	—	—	—	3	—	—	—	—	—	—
22	Weever (*T. draco*, L.)	—	2	—	—	—	—	—	—	—	—	3
23	Thornback (below 12 in.)	—	—	—	—	3	1	—	1	—	—	—
	R. clavata, L. (12 in. & above)	—	—	—	—	4	—	—	—	—	—	—
24	Homelyn (below 12 in.)	—	—	1	—	—	—	—	1	—	—	—
	R. maculata, Mon. (12 in. & above)	—	—	—	—	—	—	—	—	—	—	—
25	Blonde (below 12 in.)	—	19	3	4	1	—	—	—	2	4	7
	R. blanda, Holt (12 in. & above)	—	6	—	—	—	—	—	—	1	—	2
26	Painted Ray (below 12 in.)	—	—	—	—	—	—	—	—	—	—	—
	R. microcellata, Mon. (12 in. & above)	—	1	2	—	—	—	—	—	—	—	—
27	*S. canicula*, Cuv.	—	—	—	—	1	—	—	—	—	—	—
28	*Acanthias vulgaris*, Risso.	—	—	—	—	—	—	—	—	—	—	—
29	Buffoon (*R. squatina*, Gün.)	—	2	—	—	—	—	—	—	—	3	—
30	Scaldback (*A. laterna*, Rond.)	—	—	—	—	—	—	—	—	—	—	3
31	Cod (*G. morrhua*, L.)	—	—	—	—	—	—	—	—	—	—	—
32	White Skate (*R. alba*, Lac.)	—	—	—	—	—	—	—	—	—	1	—
33	*Agonus cataphractus*, Bl.	—	—	—	—	1	—	—	—	—	—	—
34	*Conger vulgaris*, Cuv.	—	—	—	—	—	—	—	—	—	—	—

	I.	I.	I.	I.	I.	II.	I.	I.	I.	I.	I.	II.	I.	I.	I.	I.	II.	II.	I.	I.
	May 22.	May 22.	May 22.	May 23.	May 24.	May 24.	June 19.	June 26.	June 27.	June 30.	July 21.	July 22.	July 22.	July 25.	Aug. 25.	Aug. 26.	Aug. 27.	Aug. 28.	Aug. 28.	Oct. 6.
	49	50	51	52	53	54	56	57	58	59	60	61	62	63	64	65	66	67	68	70
	2 hours.	2 hours.	3 hours.	1h. 45m.	2h. 30m.	1 hour.	1 hour.	1 hour.	1h. 30m.	3 hours.	2h. 25m.	50 min.	1h. 30m.	1h. 45m.	1 hour.	3 hours.	1h. 15m.	30 min.	2 hours.	1h. 30m.
1	—	—	—	2	—	—	29	59	129	122	32	—	30	9	175	111	279	52	260	67
	7	12	12	12	8	8	11	10	14	22	3	—	5	4	44	24	18	8	23	2
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	9	3	1	1	—	—	5	6	1	4	1
4	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	1	—	—	—	—	—	—	—	2	—	—	—	—	—	6	1	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	1	1	5	1	—	—	—	1	—	5	1	1	—
	35	42	74	57	54	7	10	38	25	94	26	4	23	5	46	78	71	23	61	16
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	1	—	—	—	—	2	4	—	—	—	—	1	—	—	1	1
11	—	—	—	—	—	—	—	2	1	2	—	—	—	—	2	—	—	—	—	6
	—	—	—	—	—	—	1	18	50	74	2	—	1	—	—	—	—	—	1	6
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	3	—	—	12	14	45	7	—	1	—	34	6	16	5	15	4
	—	1	—	—	1	—	—	1	1	4	—	—	—	—	—	5	2	1	6	12
15	—	—	—	1	1	—	—	—	—	5	1	—	—	—	1	7	11	6	1	3
16	—	—	—	—	—	—	—	—	2	13	—	—	—	—	4	2	—	—	2	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	2	4	3	2	1	8	1	7	7	1	—	1	2	—	1	4	1	1	—
	—	4	13	1	1	—	—	—	2	—	1	—	—	—	—	—	7	1	1	7
19	—	—	—	—	—	—	—	2	14	—	3	—	—	—	—	—	—	3	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	6	6	5	—	—	—	—	—	3	2	—	1
22	—	1	—	—	—	—	—	—	1	5	—	—	—	—	5	7	—	—	—	—
23	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	6	4	9	—
	1	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	2	1	1	—
24	1	1	1	—	1	—	1	—	—	6	3(?)	—	1(?)	—	—	1	—	—	2	—
	—	—	1	—	—	—	—	—	—	—	8(?)	—	—	—	—	—	—	—	—	—
25	—	2	5	—	5	—	—	—	—	2	4(?)	—	1(?)	—	1	—	—	1	2	—
	—	—	2	—	—	—	—	—	—	13	13(?)	—	—	—	—	1	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	1	—	1	—	—	—	—	—	—	—	1	2	—	—	—	—	1	1	—	—
30	—	—	—	—	—	—	2	—	3	—	—	—	—	—	—	—	2	—	—	1
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

TABLE C—*continued.*

TORBAY.

STATION.	IV.	VI.	V.	IV.	VI.	IVA.	V.	IV.	IVA.	IVA.	V.	IVA.	V.	IVA.	VI.
DATE. 1901.	July 31.	July 31.	Aug. 1.	Sept. 11.	Sept. 11.	Sept. 12.	Sept. 12.	Oct. 7.	Oct. 7.	Oct. 10.	Oct. 10.	Oct. 11.	Nov. 11.	Nov. 12.	Nov. 14.
HAUL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DURATION OF HAUL.	1h. 40m.	1h. 10m.	1h. 5m.	1h. 30m.	1h. 30m.	1 hour.	1 hour.	1h. 15m.	1 hour.	1 hour.	1h. 15m.	1 hour.	1 hour.	50 min.	1 hour.
1 Dab (below 8 in.) . . .	117	10	58	265	12	28	66	145	7	—	98	2	67	—	5
P. limanda, L. (8 in. & above)	3	14	4	17	20	2	25	7	3	2	12	—	10	2	15
2 Flounder (below 8 in.) . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P. flesus, L. (8 in. and above)	8	—	—	12	—	4	—	3	4	1	—	1	—	1	—
3 Sole (below 8 in.) . . .	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
S. vulgaris, Quen. (8 in. & above)	3	1	1	4	2	3	1	1	—	1	1	—	—	—	1
4 Sand Sole (*S. lascaris*, Risso.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5 Thickback (*S. variegata*, Flem.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6 Solenette (*S. lutea*, Bon.) .	29	1	5	7	—	—	—	many	—	—	—	—	1	—	1
7 Lemon Sole (*P. microcephalus*, Don.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8 Plaice (below 8 in.) . .	40	3	7	135	1	5	2	96	14	4	8	8	1	—	—
P. platessa, L. (8 in. & above)	39	11	22	71	7	32	33	35	20	20	39	18	20	11	7
9 Turbot (below 10 in.) . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R. maximus, Kl. (10 in. & above)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10 Brill (below 10 in.) . .	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
R. lævis, Kl. (10 in. and above)	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—
11 Whiting (below 8 in.) . .	2	1	4	1	1	—	—	3	—	—	1	—	7	—	2
G. merlangus, L. (8 in. & above)	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—
12 Bib (*G. luscus*, L.) . .	—	—	—	—	3	103	—	—	—	—	—	—	—	—	—
13 Poor Cod (*G. minutus*, L.) .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14 Grey Gurnard (below 8 in.) .	31	7	38	2	—	—	—	—	—	—	—	1	3	—	3
T. gurnardus, L. (8 in. & above)	1	—	—	—	1	1	—	—	—	—	—	—	1	—	—
15 Tub (*T. lucerna*, Will.) .	14	—	—	2	—	1	—	4	3	—	2	4	2	—	—
16 Red Gurnard (*T. pini*, Bl.) .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17 Streaked Gurnard (*T. lineata*, L.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18 Dory (below 8 in.) . .	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Z. faber, L. (8 in. and above)	—	—	—	1	—	2	—	—	—	—	—	2	—	—	—
19 Mullet (below 8 in.) . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
M. surmuletus, L. (8 in. & above)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20 Bream (*P. centrodontus*, C. et V.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21 Dragonet (*C. lyra*, L.) . .	24	22	24	30	—	—	—	6	—	—	—	—	6	—	12
22 Weever (*T. draco*, L.) . .	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
23 Thornback (below 12 in.) . .	32	88	20	9	7	—	2	26	5	1	9	6	—	—	15
R. clavata, L. (12 in. & above)	—	6	3	—	1	—	—	—	—	—	—	—	—	—	—
24 Homelyn (below 12 in.) .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
R. maculata, Mon. (12 in. and above)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25 Blonde (below 12 in.) . .	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—
R. blanda, Holt (12 in. & above)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26 Painted Ray (below 12 in.) .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R. microcellata, Mon. (12 in. and above) . . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27 *S. canicula*, Cuv. . . .	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
28 *Acanthias vulgaris*, Risso. .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29 Buffoon (*R. squatina*, Gün.) .	6	1	—	4	5	4	—	—	1	—	—	—	1	1	—
30 Scaldback (*A. laterna*, Rond.)	25	8	9	30	4	6	10	few	few	—	many	3	few	—	2
31 Cod (*G. morrhua*, L.) . .	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—
32 White Skate (*R. alba*, Lac.) .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33 *Agonus cataphractus*, Bl. .	2	2	—	1	1	—	—	3	—	—	—	—	—	—	—
34 *Conger vulgaris*, Cuv. . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

	V.	IVa.	IV.	V.	IV.	VI.	IVa.	V.	VI.	IVa.	IV.	IVa.	IV.	V.	V.	IVa.	VI.	V.	IV.	IVa.	VI.
	Nov. 15.	Nov. 15.	Dec. 12.	Dec. 14.	1902. Jan. 28.	Jan. 29.	April 17.	April 17.	April 19.	May 26.	May 26.	July 2.	July 2.	July 3.	July 24.	July 24.	July 24.	Sept. 1.	Sept. 1.	Sept. 1.	Sept. 4.
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	1 hour.	1h. 30m.	2 hours.	45 min.	1 hour.	45 min.	1h. 30m.	1h. 15m.	1 hour.	40 min.	1 hour.	1 hour.	30 min.	1 hour.	1h. 30m.	1 hour.	1 hour.	45 min.	1 hour.	1 hour.	1 hour.
1	67	9	16	28	7	3	36	74	10	–	–	11	42	346	–	12	2	287	223	112	10
	6	—	3	7	—	–	2	2	9	3	2	—	1	8	1	—	4	12	9	4	12
2	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
	6	—	—	—	1	–	1	—	—	–	2	2	4	—	–	3	—	—	9	3	—
3	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
	—	—	—	—	—	–	—	—	—	–	1	—	—	1	–	1	—	1	2	2	—
4	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
5	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
6	few	few	—	—	1	–	5	20	—	–	–	—	—	3	–	—	—	—	1	—	1
7	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	1	—	—	—	—
8	123	30	4	—	30	7	39	38	11	–	–	7	13	47	–	7	1	10	36	18	2
	15	17	7	10	8	3	5	24	8	4	4	9	7	28	6	5	4	22	114	65	3
9	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
10	2	1	2	—	—	–	1	—	—	–	–	—	—	—	–	—	—	—	—	—	—
	—	—	—	—	—	–	—	—	1	–	–	—	—	—	–	—	—	—	—	—	—
11	42	—	1	14	—	–	—	—	—	–	–	—	1	23	–	—	10	56	8	—	34
	2	—	—	—	—	–	—	—	—	–	–	—	—	3	–	—	—	1	1	—	—
12	—	—	—	—	—	–	—	—	—	–	–	—	1	—	–	3	—	—	3	3	—
13	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	3
14	7	—	—	7	—	–	—	2	5	–	–	5	3	57	–	4	4	3	2	—	1
	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	1	—	—	—
15	—	—	—	—	—	–	2	—	—	–	–	—	3	—	–	3	3	1	—	14	—
16	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	1
17	—	—	—	—	—	–	—	—	1	–	–	—	—	—	–	—	—	—	—	—	—
18	—	1	—	—	—	–	—	—	1	–	–	—	—	—	1	—	1	1	1	—	1
	—	2	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
19	—	—	—	—	—	–	—	—	—	–	–	—	1	—	–	—	—	—	1	1	—
	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
20	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
21	few	—	—	3	—	–	1	—	—	–	–	—	—	12	–	—	—	12	—	—	—
22	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
23	18	4	—	—	1	1	—	2	15	2	–	—	1	4	–	7	7	6	12	—	40
	—	—	—	—	—	–	—	—	—	–	–	—	—	—	1	—	9	—	—	—	4
24	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
25	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
26	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
27	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
28	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
29	—	3	—	—	—	2	—	—	—	–	–	—	—	—	–	—	—	—	4	—	9
30	—	—	—	3	—	–	5	12	—	–	–	—	—	6	–	—	—	3	3	—	2
31	—	—	—	—	1	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
32	1	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	—	—	—	—
33	3	2	—	—	—	–	2	3	—	–	–	—	—	—	–	—	—	—	—	—	—
34	—	—	—	—	—	–	—	—	—	–	–	—	—	—	–	—	—	1	—	—	—

TABLE C—*continued.*

TEIGNMOUTH BAY.

	Station.	VII.	IX.	VIII.	VII.	VII.	VIII.	VII.	VIII.	VII.	VII.	VII.	VIII.
	Date.	1901. Aug. 1.	Aug. 1.	Aug. 2.	Sept. 13.	Sept. 13.	Sept. 13.	Oct. 9.	Oct. 9.	Oct. 11.	Nov. 11.	Nov. 13.	Nov. 13.
	Haul.	1	2	3	4	5	6	7	8	9	10	11	12
	Duration of Haul.	1 hour.	2 hours.	1h. 50m.	1h. 30m.	1h. 30m.	2h. 35m.	2h. 15m.	1h. 15m.	1h. 15m.	1h. 5m.	1h. 30m.	2 hours.
1	Dab (below 8 in.)	21	—	2	40	19	8	57	—	2	12	42	14
	P. limanda, L. (8 in. and above)	13	—	3	5	6	10	28	2	1	9	44	14
2	Flounder (below 8 in.)	—	—	—	—	—	—	—	—	—	—	—	—
	P. flesus, L. (8 in. and above)	—	—	1	—	—	—	—	—	—	—	—	—
3	Sole (below 8 in.)	—	1	—	—	—	1	—	—	—	—	1	2
	S. vulgaris, Quen. (8 in. and above)	—	8	6	1	—	8	3	—	1	3	9	26
4	Sand Sole (*S. lascaris*, Risso.)	—	—	—	—	—	—	—	—	—	—	—	—
5	Thickback (*S. variegata*, Flem.)	—	—	—	—	—	—	—	—	—	—	—	—
6	Solenette (*S. lutea*, Bon.)	1	2	1	31	2	6	6	—	—	1	60	6
7	Lemon Sole (*P. microcephalus*, Don.)	—	—	—	1	—	2	—	—	—	—	—	—
8	Plaice (below 8 in.)	27	—	10	7	43	55	212	30	133	144	10	—
	P. platessa, L. (8 in. and above)	22	2	7	29	42	85	112	29	32	86	52	11
9	Turbot (below 10 in.)	—	—	—	—	—	—	—	—	—	—	—	—
	R. maximus, Kl. (10 in. and above)	—	—	—	—	—	—	—	1	1	—	—	1
10	Brill (below 10 in.)	—	—	1	—	—	4	1	1	3	3	1	1
	R. lævis, Kl. (10 in. and above)	—	3	1	—	—	1	—	1	—	—	—	—
11	Whiting (below 8 in.)	—	—	1	1	—	—	—	1	—	—	116	5
	G. merlangus, L. (8 in. and above)	—	—	—	—	—	—	—	—	—	—	38	58
12	Bib (*G. luscus*, L.)	—	—	—	1	275	2	—	—	—	—	11	29
13	Poor Cod (*G. minutus*, L.)	—	—	—	—	—	—	—	—	—	—	—	3
14	Grey Gurnard (below 8 in.)	—	12	3	1	—	1	3	1	—	23	5	4
	T. gurnardus, L. (8 in. and above)	—	3	—	—	—	—	—	—	—	—	—	—
15	Tub (*T. lucerna*, Will.)	10	—	6	1	3	28	15	8	6	1	—	—
16	Red Gurnard (*T. pini*, Bl.)	—	—	—	—	—	—	—	—	—	—	—	—
17	Streaked Gurnard (*T. lineata*, L.)	—	—	—	—	—	—	—	—	—	—	—	—
18	Dory (below 8 in.)	—	—	2	—	—	—	—	—	—	—	1	—
	Z. faber, L. (8 in. and above)	—	—	1	1	1	—	—	—	—	1	—	3
19	Mullet (below 8 in.)	—	—	—	—	—	—	—	—	—	—	—	—
	M. surmuletus, L. (8 in. and above)	—	—	—	—	—	—	—	—	—	—	—	3
20	Bream (*P. centrodontus*, C. et V.)	—	—	—	—	—	2	—	—	—	—	—	—
21	Dragonet (*C. lyra*, L.)	11	60	4	12	7	50	—	few	few	7	few	6
22	Weever (*T. draco*, L.)	—	—	—	—	—	—	—	—	—	—	—	—
23	Thornback (below 12 in.)	—	17	4	37	7	19	63	1	—	31	59	36
	R. clavata, L. (12 in. and above)	8	11	5	3	8	26			—	3	6	25
24	Homelyn (below 12 in.)	—	—	—	—	—	2	2	—	—	—	—	3
	R. maculata, Mon. (12 in. and above)	—	—	—	—	—	—		—	—	—	—	—
25	Blonde (below 12 in.)	—	—	—	—	—	3	—	8	—	1	—	—
	R. blanda, Holt (12 in. and above)	—	—	—	—	—	6	—		—	—	—	9
26	Painted Ray (below 12 in.)	—	—	—	—	—	—	—	3	1	—	—	—
	R. microcellata, Mon. (12 in. and above)	—	—	—	—	—	19	—			—	—	1
27	*S. canicula*, Cuv.	—	16	1	3	—	—	—	—	—	1	—	many
28	*Acanthias vulgaris*, Risso.	—	—	—	—	—	—	—	—	—	—	—	—
29	Buffoon (*R. squatina*, Gün.)	35	—	2	3	44	12	many	12	many	—	few	—
30	Scaldback (*A. laterna*, Rond.)	8	10	5	12	2	21	30	—	1	—	few	6
31	Cod (*G. morrhua*, L.)	—	—	—	—	—	1	—	—	—	—	1	—
32	White Skate (*R. alba*, Lac.)	1	—	—	—	—	—	—	—	—	—	1	—
33	*Agonus cataphractus*, Bl.	—	—	—	1	—	—	—	—	—	—	2	—
34	*Conger vulgaris*, Cuv.	—	—	—	—	—	—	—	—	—	—	—	—

	VIII.	VII.	VIII.	VII.	VIII.	VII.	IX.	VIII.	VII.	VII.	VIII.	IX′.	IX.	IX.	VIII.	VII.	IX.	VIII.	VII.	VIII.
	Nov. 14.	Dec. 11.	Dec. 13.	1902. Jan. 28.	Jan. 28.	April 17.	April 17.	April 18.	April 18.	May 27.	May 27.	May 27.	May 28.	July 2.	July 2.	July 5.	July 5.	July 23.	Sept. 4.	Sept. 4.
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	2 hours.	3h. 30m.	1 hour.	1h. 30m.	45 min.	1h. 30m.	1 hour.	3 hours.	2 hours.	1h. 45m.	1h. 45m.	2 hours.	1h. 30m.	1h. 30m.	1 hour.	45 min.	1 hour.	1h. 40m.	45 min.	1h. 30m.
1	10	12	2	4	—	7	1	2	1	—	—	—	—	3	—	88	68	3	52	9
	12	2	2	—	—	3	—	4	2	—	1	1	—	—	1	2	7	—	7	2
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
3	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	12	—	1	—	—	—	—	2	2	—	3	2	—	4	2	—	2	—	1	21
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	3	—	—	—	—	?	—	—	—	—	—	—	—	—	—	few	—	—	—
7	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	2	89	5	74	4	84	—	67	39	—	—	1	—	3	5	18	78	8	26	21
	9	12	1	9	2	19	8	24	6	5	5	19	15	5	10	3	38	1	33	49
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
10	1	3	—	—	—	1	—	4	—	—	—	1	—	—	—	—	—	—	—	1
	—	—	—	—	—	—	—	—	—	—	2	—	—	2	—	—	—	—	—	—
11	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	3	—	3	1
	17	—	1	—	—	—	—	—	—	—	—	—	—	3	—	—	3	—	—	—
12	few	—	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	8
13	—	—	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	5	—	—	—	3	5	1	1	—	—	—	—	4	—	22	41	2	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
15	1	6	—	—	—	—	—	—	6	—	—	—	—	3	1	2	—	—	3	15
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	2	4	—	—	—	—	—	1
	1	—	—	—	—	—	—	—	—	—	3	—	2	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	—	—	—	3
	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	few	few	few	—	—	—	?	—	—	—	—	—	—	—	—	—	few	7	few	few
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
23	few	12	6	4	1	58	4	50	32	2	—	7	5	2	—	14	45	—	3	±25
		—	18	—	3	11	12	50	10	2	17	19	10	10	4	12	9	8	—	
24	—	—	—	—	—	—	—	—	1	1	1	4	—	2	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	7	6	—	—	—	—	—	—	—	—
25	few	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	±25
		—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	
26	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
27	6	—	3	—	—	1	few	—	—	—	—	—	—	12	—	—	1	3	—	few
28	—	—	—	—	—	—	few	—	—	—	—	—	—	—	—	—	—	—	—	—
29	3	many	—	2	4	20	few	—	—	—	—	—	—	—	—	—	2	1	12	3
30	—	2	—	—	1	6	—	—	—	—	—	—	—	—	—	—	many	—	2	few
31	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

TABLE D.

Record of Plaice caught.

I. START BAY.

No. of haul.	Year.	Month.	Day.	Station.	Duration of haul		(Inches.)																						Total.
					h.	m.	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
1	1901	July	30	II.	2	35	–	1	3	15	6	2	2	2	2	10	7	2	2	–	1	1	2	–	–	–	–	–	58
2	,,	,,	,,	I.	2	0	–	1	1	3	1	–	1	2	—	6	4	2	—	–	–	–	–	–	–	–	–	–	21
3	,,	Aug.	7	I.	2	0	–	1	–	1	1	–	1	1	7	4	5	1	—	–	–	–	–	–	–	–	–	–	22
4	,,	,,	8	I.	1	10	–	–	–	1	1	2	1	5	7	2	5	1	—	–	–	–	–	–	–	–	–	–	25
5	,,	,,	9	II.	1	10	–	–	–	—	–	–	–	–	—	—	—	1	1	2	1	–	–	–	–	–	–	–	5
6	,,	Sept.	6	III.	2	0	–	–	–	—	2	1	3	4	4	7	7	2	5	3	–	1	–	–	–	–	–	–	39
7	,,	,,	7.	III.	2	0	–	–	–	—	–	–	–	–	5	12	18	20	10	3	4	–	–	–	–	–	–	–	72
8	,,	,,	,,	II.	2	0	–	–	–	11	–	1	–	1	3	4	5	2	1	–	3	1	1	–	–	–	–	–	33
9	,,	,,	9	I.	1	55	–	–	–	—	1	–	–	–	4	7	2	7	—	3	2	–	–	–	–	–	–	–	26
10	,,	,,	,,	II.	2	0	–	–	–	2	5	4	7	5	5	11	5	6	5	1	2	1	–	–	–	–	–	–	59
11	,,	,,	,,	I.	1	5	–	–	–	—	–	6	3	2	3	7	5	3	1	–	–	–	–	–	–	–	–	–	30
12	,,	,,	10	III.	2	0	–	–	–	—	–	–	–	–	1	6	5	10	5	3	–	–	–	–	–	–	–	–	30
13	,,	,,	,,	I.	1	15	–	–	–	—	–	1	2	1	2	4	6	5	2	1	–	–	–	–	–	–	–	–	24
14	,,	Oct.	1	III.	1	10	–	–	–	—	–	–	–	–	—	—	5	5	3	1	–	3	–	–	–	–	–	–	17
15	,,	,,	,,	II.	2	0	–	–	–	—	1	1	1	–	3	1	6	2	3	–	–	–	–	–	2	–	–	–	20
16	,,	,,	2	I.	2	15	–	1	–	1	–	8	8	8	19	18	33	21	6	2	1	–	–	–	–	–	–	–	126
17	,,	,,	3	I.	1	30	–	–	–	1	2	8	2	6	14	18	8	7	4	1	–	–	–	–	–	–	–	–	71
18	,,	,,	,,	I.	2	0	–	–	–	1	1	5	4	3	10	16	19	15	8	6	2	–	–	–	–	–	–	–	90
19	,,	,,	,,	II.	1	0	–	–	–	—	–	1	1	3	—	—	—	–	1	2	2	–	–	1	2	–	–	1	14
20	,,	,,	4	I.	1	10	–	–	–	—	5	2	6	7	9	14	14	11	9	1	–	–	–	–	–	–	–	–	78
21	,,	,,	11	I.	2	0	–	–	–	2	–	2	1	1	2	—	1	5	2	2	–	–	–	–	–	–	–	–	18
22	,,	Nov.	6	I.	2	0	–	–	–	—	2	5	3	4	7	22	14	7	4	1	–	–	–	–	–	–	–	–	69
23	,,	,,	,,	III.	1	0	–	–	–	—	–	–	–	–	—	3	1	6	5	2	–	–	–	–	–	–	–	–	17
24	,,	,,	7	I.	3	0	–	–	–	—	1	–	–	4	6	1	12	8	6	1	1	–	–	–	–	–	–	–	40
25	,,	,,	8	II.	1	50	–	–	–	2	2	6	1	4	3	3	3	4	–	–	–	–	2	1	–	–	–	–	31
26	,,	,,	9	I.	3	0	–	–	–	—	1	1	1	3	4	4	17	15	10	5	3	–	–	1	1	–	–	–	66
27	,,	,,	,,	II.	2	5	–	–	–	—	–	–	1	2	5	12	15	23	3	1	–	–	1	–	1	–	–	–	64
28	,,	,,	,,	II.	1	0	–	–	–	—	1	1	2	4	6	5	11	6	4	–	1	–	–	2	–	–	–	–	43
29	,,	,,	15	I.	2	30	–	–	1	—	1	1	1	–	5	2	10	10	5	4	–	1	2	–	–	–	–	–	43
30	,,	,,	16	II*a*.	0	40	–	–	–	—	–	1	2	5	5	9	10	11	1	–	1	–	2	–	–	–	–	–	47
31	,,	Dec.	17	I.	3	0	–	1	–	—	–	–	–	2	5	5	5	7	3	2	–	–	–	–	–	–	–	–	30
32	,,	,,	,,	III.	3	10	–	–	–	—	–	1	3	1	7	7	5	2	2	1	1	–	–	–	–	–	–	–	30
33	,,	,,	,,	I.	3	0	–	–	–	1	–	3	3	3	4	10	1	3	1	1	–	–	1	–	–	–	–	–	31
34	,,	,,	18	I.	3	0	–	–	–	—	1	–	–	2	1	3	3	4	2	2	3	–	–	–	1	–	–	–	22
35	,,	,,	,,	I.	3	0	–	–	–	—	1	–	–	1	4	3	3	4	2	1	2	–	1	–	–	–	–	–	22
36	,,	,,	19	I.	3	0	–	–	–	—	–	–	1	3	1	—	3	5	1	1	1	1	–	–	–	–	–	–	17
37	,,	,,	,,	I.	4	0	–	–	1	1	1	1	6	5	8	9	10	6	3	4	–	–	1	1	1	–	–	–	58
																		Total, 1901 . . .											1508

TABLE D—*continued.*

Record of Plaice caught.

I. START BAY—*continued.*

No. of haul.	Year.	Month.	Day.	Station.	Duration of haul.	(Inches.)																						Total.
					h. m.	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
38	1902	Jan.	21	I.	1 45	-	-	-	-	—	—	—	—	1	2	—	—	—	-	-	-	-	-	-	-	-	-	3
39	,,	,,	22	III.	1 30	-	-	-	-	—	—	—	—	—	—	1	—	1	-	-	-	-	-	-	-	-	-	2
40	,,	,,	24	I.	3 30	-	-	1	2	3	2	2	5	5	6	5	2	2	-	1	-	-	-	-	-	-	-	36
41	,,	,,	25	I.	1 0	-	1	-	-	1	—	2	—	2	2	3	2	1	1	1	2	-	-	-	-	-	-	18
42	,,	Feb.	4	I.	1 45	3	2	2	-	5	—	9	6	2	1	3	3	1	-	-	-	-	-	1	-	-	-	38
43	,,	,,	5	I.	1 15	-	-	-	1	3	—	—	3	2	2	—	1	4	-	2	-	-	-	-	-	-	-	18
44	,,	Apr.	8	I.	0 40	-	1	1	-	—	—	—	—	—	—	1	—	—	-	-	-	-	-	-	-	-	-	3
45	,,	,,	14	I.	1 0	-	-	-	1	—	2	4	4	3	—	1	1	1	-	-	-	-	-	-	-	-	-	17
46	,,	,,	15	III.	1 0	-	-	-	-	—	—	—	—	—	—	—	—	1	-	1	-	-	-	1	-	-	-	3
47	,,	,,	,,	I.	2 30	-	2	1	-	—	—	1	2	8	4	6	3	6	3	-	-	-	-	-	-	-	-	36
48	,,	,,	,,	III.	2 0	3	3	1	-	—	—	—	—	—	2	3	3	—	-	1	-	-	-	-	-	-	-	16
49	,,	May	22	I.	2 0	-	-	-	-	—	—	1	3	3	4	10	4	7	1	-	-	-	1	1	-	-	-	35
50	,,	,,	,,	I.	2 0	-	-	-	-	—	1	2	3	6	5	8	5	5	6	-	-	-	-	1	-	-	-	42
51	,,	,,	,,	I.	3 0	-	-	-	-	—	1	9	7	14	11	13	7	4	4	2	1	-	-	-	-	1	-	74
52	.,	,,	23	I.	1 45	-	-	-	-	—	2	3	6	10	7	10	8	7	1	-	3	-	-	-	-	-	-	57
53	,,	,,	24	I.	2 30	-	-	-	-	—	1	2	4	10	6	8	9	11	1	-	1	-	-	2	-	-	-	54
54	,,	,,	,,	II.	1 0	-	-	-	-	—	—	—	5	1	—	—	1	—	-	-	-	-	-	-	-	-	-	7
55	,,	,,	29	I.	6 0	-	-	-	-	—	—	3	8	6	12	7	4	4	1	6	1	-	-	-	-	-	-	52
56	,,	June	19	I.	1 0	-	-	-	-	3	—	1	1	3	2	—	—	—	-	-	-	-	-	-	-	-	-	10
57	,,	,,	26	I.	1 0	-	-	1	-	2	—	3	9	4	4	7	3	4	2	-	-	-	-	-	-	-	-	39
58	,,	,,	27	I.	1 30	-	-	-	1	—	—	3	2	4	8	3	3	—	-	1	1	-	-	-	-	-	-	26
59	,,	,,	30	I.	3 0	-	-	2	3	3	3	11	15	14	17	13	4	4	4	2	1	1	-	-	-	1	1	99
60	,,	July	21	I.	2 25	-	-	-	1	3	—	2	2	6	4	3	1	3	-	-	-	1	-	1	-	-	-	27
61	,,	,,	22	II.	1 50	-	-	-	-	—	—	1	—	3	—	—	—	—	-	-	-	-	-	-	-	-	-	4
62	,,	,,	,,	I.	1 30	-	-	-	-	—	1	6	5	5	3	2	1	—	-	-	-	-	-	-	-	-	-	23
63	,,	,,	25	I.	1 45	-	-	-	-	—	—	—	2	2	1	—	—	—	-	-	-	-	-	-	-	-	-	5
64	,,	Aug.	25	I.	1 0	-	-	1	-	6	2	4	7	4	8	7	5	1	1	-	1	-	-	-	-	-	-	47
65	,,	,,	26	I.	3 0	-	-	-	-	10	11	6	10	5	7	9	11	4	2	2	-	-	1	-	-	-	-	78
66	,,	,,	27	II.	1 15	-	-	-	5	10	17	9	15	11	5	2	—	—	1	-	1	-	-	-	-	-	-	76
67	,,	,,	28	II.	0 30	-	-	-	1	5	4	1	3	5	2	—	2	—	-	-	-	-	1	-	-	-	-	24
68	,,	,,	,,	I.	2 0	-	-	-	1	4	7	7	10	12	7	4	4	3	1	1	1	-	-	-	-	-	-	62
69	,,	,,	,,	I.	3 0	-	-	-	2	4	3	8	6	6	6	12	4	6	-	-	-	-	-	-	-	-	-	57
70	,,	Oct.	6	I.	1 30	-	-	-	-	1	3	2	2	4	—	—	—	2	-	-	1	-	1	-	-	-	-	16
																											Total, 1902 .	1104
																											,, 1901 .	1508
																											Grand total .	2612

TABLE D—*continued.*

Record of Plaice caught.

II. TORBAY.

No. of haul.	Year.	Month.	Day.	Station.	Duration of haul.		(Inches.)																					Total.
					h.	m.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1	1901	July	31	IV.	1	40	8	7	1	8	16	12	2	2	5	3	4	9	2	–	–	–	–	–	–	–	–	79
2	,,	,,	,,	VI.	1	10	–	—	—	—	3	2	2	2	–	1	–	3	1	–	–	–	–	–	–	–	–	14
3	,,	Aug.	1	V.	1	5	1	—	—	2	4	1	1	—	4	7	4	1	2	2	–	–	–	–	–	–	–	29
4	,,	Sept.	11	IV.	1	30	5	103	17	5	5	13	14	3	9	9	10	7	5	–	–	1	–	–	–	–	–	206
5	,,	,,	,,	VI.	1	30	–	1	—	—	—	1	3	1	–	–	1	1	–	–	–	–	–	–	–	–	–	8
6	,,	,,	12	IVA.	1	0	–	1	2	—	2	9	5	1	–	1	2	5	3	1	–	2	–	2	–	1	–	37
7	,,	,,	,,	V.	1	0	–	—	—	—	2	9	2	5	3	7	2	4	1	–	–	–	–	–	–	–	–	35
8	,,	Oct.	7	IV.	1	15	7	62	23	—	4	9	8	4	1	5	6	–	–	–	1	–	1	–	–	–	–	131
9	,,	,,	,,	IVA.	1	0	1	8	3	—	2	3	4	—	1	1	2	1	1	–	2	2	2	1	–	–	–	34
10	,,	,,	10	IVA.	1	0	–	1	1	2	—	5	3	—	–	–	1	3	4	1	–	1	1	–	–	–	1	24
11	,,	,,	,,	V.	1	15	–	2	—	2	4	3	2	—	8	8	5	6	4	1	2	–	–	–	–	–	–	47
12	,,	,,	11	IVA.	1	0	–	3	4	—	1	6	5	2	–	–	2	–	1	1	–	1	–	–	–	–	–	26
13	,,	Nov.	11	V.	1	0	–	—	—	—	1	2	1	1	4	9	3	–	–	–	–	–	–	–	–	–	–	21
14	,,	,,	12	IVA.	0	50	–	—	—	—	—	2	1	2	–	–	2	2	–	1	–	–	–	–	–	–	1	11
15	,,	,,	14	VI.	1	0	–	—	—	—	—	—	1	—	–	2	1	1	–	2	–	–	–	–	–	–	–	7
16	,,	,,	15	V.	1	0	–	64	57	2	—	2	2	2	–	3	2	1	1	–	1	–	–	1	–	–	–	138
17	,,	,,	,,	IVA.	1	30	2	15	10	1	2	7	—	2	–	–	1	–	–	1	–	–	4	1	–	1	–	47
18	,,	Dec.	12	IV.	2	0	–	1	1	2	—	—	1	1	1	2	1	1	–	–	–	–	–	–	–	–	–	11
19	,,	,,	14	V.	0	45	–	—	—	—	—	—	—	—	–	5	1	–	3	1	–	–	–	–	–	–	–	10
																					Total, 1901 .							915
20	1902	Jan.	28	IV.	1	0	1	8	17	4	—	—	—	3	–	1	1	1	–	–	–	–	–	–	1	1	–	38
21	,,	,,	29	VI.	0	45	–	2	3	2	—	1	—	—	–	–	2	–	–	–	–	–	–	–	–	–	–	10
22	,,	April	17	IVA.	1	30	1	15	16	5	2	—	1	1	–	2	–	–	–	–	–	–	–	1	–	–	–	44
23	,,	,,	,,	V.	1	15	1	6	16	14	1	5	4	3	1	1	6	1	1	1	1	–	–	–	–	–	–	62
24	,,	,,	19	VI.	1	0	–	1	3	6	1	3	—	1	–	1	1	1	–	–	–	–	1	–	–	–	–	19
25	,,	May	26	IVA.	0	40	–	—	—	—	—	—	—	—	1	1	–	–	–	2	–	–	–	–	–	–	–	4
26	,,	,,	,,	IV.	1	0	–	—	—	—	—	—	—	—	1	3	–	–	–	–	–	–	–	–	–	–	–	4
27	,,	July	2	IVA.	1	0	–	1	—	4	2	4	1	1	–	1	–	–	–	1	–	1	–	–	–	–	–	16
28	,,	,,	,,	IV.	0	30	–	—	1	6	6	3	—	—	–	–	1	1	–	–	–	1	–	–	1	–	–	20
29	,,	,,	3	V.	1	0	–	—	4	30	13	7	1	8	3	1	1	3	–	3	–	–	1	–	–	–	–	75
30	,,	,,	24	V.	1	30	–	—	—	—	—	1	—	—	1	2	–	1	1	–	–	–	–	–	–	–	–	6
31	,,	,,	,,	IVA.	1	0	1	—	—	3	3	2	3	—	–	–	–	–	–	–	–	–	–	–	–	–	–	12
32	,,	,,	,,	VI.	1	0	–	—	—	1	—	1	1	—	–	–	1	–	–	–	–	1	–	–	–	–	–	5
33	,,	Sept.	1	V.	0	45	–	1	—	—	9	6	4	—	5	1	1	3	1	–	–	1	–	–	–	–	–	32
34	,,	,,	,,	IV.	1	0	2	9	1	3	21	53	34	16	2	2	2	2	–	2	–	–	–	–	1	–	–	150
35	,,	,,	,,	IVA.	1	0	–	3	—	4	11	24	17	10	3	3	2	–	–	1	–	–	1	–	3	–	1	83
36	,,	,,	4	VI.	1	0	–	—	—	—	2	1	—	—	1	–	–	–	–	–	–	–	1	–	–	–	–	5
																					Total, 1902 .							585
																					,, 1901 .							915
																					Grand Total .							1500

TABLE D—*continued.*

Record of Plaice caught.

III. TEIGNMOUTH BAY.

No. of haul.	Year.	Month.	Day.	Station.	Duration of haul.		(Inches.)																							Total.
					h.	m.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
1	1901	Aug.	1	VII.	1	0	2	—	—	18	7	5	1	—	2	2	4	3	1	1	1	2	–	–	–	–	–	–	–	49
2	,,	,,	,,	IX.	2	0	–	—	—	—	—	1	—	1	—	—	—	—	—	–	–	–	–	–	–	–	–	–	–	2
3	,,	,,	2	VIII.	1	50	1	—	4	3	2	—	—	1	—	2	1	1	—	–	1	–	1	–	–	–	–	–	–	17
4	,,	Sept.	13	VII.	1	30	1	1	—	1	4	6	4	1	5	5	2	3	1	–	2	–	–	–	–	–	–	–	–	36
5	,,	,,	,,	VII.	1	30	–	18	3	6	16	6	1	4	3	2	4	5	5	2	3	5	1	–	–	1	–	–	–	85
6	,,	,,	,,	VIII.	2	35	1	4	6	27	17	10	3	8	10	4	7	17	10	4	5	7	–	–	–	–	–	–	–	140
7	,,	Oct.	9	VII.	2	15	8	124	56	5	19	38	13	9	13	12	9	6	4	7	–	–	1	–	–	–	–	–	–	324
8	,,	,,	,,	VIII.	1	15	–	5	2	8	15	6	1	4	—	1	2	—	6	3	–	4	–	1	–	–	1	–	–	59
9	,,	,,	11	VII.	1	15	2	77	46	5	3	2	1	1	4	6	8	5	1	2	–	–	–	1	–	–	–	–	1	165
10	,,	Nov.	11	VII.	1	5	–	52	77	10	5	12	9	11	14	11	10	9	2	3	3	–	1	1	–	–	–	–	–	230
11	,,	,,	13	VII.	1	30	–	2	8	—	—	6	2	4	6	10	8	5	6	–	2	–	3	–	–	–	–	–	–	62
12	,,	,,	,,	VIII.	2	0	–	—	—	—	—	3	1	1	1	1	1	—	–	1	–	–	1	1	–	–	–	–	–	11
13	,,	,,	14	VIII.	2	0	–	1	1	—	—	1	—	1	3	—	1	2	–	–	–	1	–	–	–	–	–	–	–	11
14	,,	Dec.	11	VII.	3	30	1	29	54	4	1	1	3	1	1	—	2	1	2	–	–	1	–	–	–	–	–	–	–	101
15	,,	,,	13	VIII.	1	0	–	1	4	—	—	—	—	1	—	—	—	—	–	–	–	–	–	–	–	–	–	–	–	6
																														1298
16	1902	Jan.	28	VII.	1	30	5	47	18	3	1	—	1	—	2	1	2	—	1	–	–	–	–	2	–	–	–	–	–	83
17	,,	,,	,,	VIII.	0	45	–	1	2	1	—	—	—	—	—	—	—	1	—	–	–	1	–	–	–	–	–	–	–	6
18	,,	April	17	VII.	1	30	2	44	30	7	1	—	—	2	2	2	2	1	2	3	4	–	1	–	–	–	–	–	–	103
19	,,	,,	,,	IX.	1	0	–	—	—	—	—	1	—	1	1	—	2	—	–	1	2	–	–	–	–	–	–	–	–	8
20	,,	,,	18	VIII.	3	0	–	33	24	9	1	3	3	—	3	3	—	3	2	2	2	1	2	–	–	–	–	–	–	91
21	,,	,,	,,	VII.	2	0	–	18	18	3	—	—	1	1	1	—	—	2	–	1	–	–	–	–	–	–	–	–	–	45
22	,,	May	27	VII.	1	45	–	—	—	—	—	—	1	—	—	—	—	1	1	1	–	1	–	–	–	–	–	–	–	5
23	,,	,,	,,	VIII.	1	45	–	—	—	—	—	—	1	—	—	3	—	—	–	–	–	–	–	1	–	–	–	–	–	5
24	,,	,,	,,	IX.	2	0	–	—	—	—	1	—	4	2	4	1	1	4	1	2	–	–	–	–	–	–	–	–	–	20
25	,,	,,	28	IX.	1	30	–	—	—	—	—	—	1	5	3	—	4	2	–	–	–	–	–	–	–	–	–	–	–	15
26	,,	July	2	IX.	1	30	–	—	—	2	1	2	1	2	—	—	—	—	–	–	–	–	–	–	–	–	–	–	–	8
27	,,	,,	,,	VIII.	1	0	–	—	—	4	1	3	—	2	—	—	2	1	1	–	–	1	–	–	–	–	–	–	–	15
28	,,	,,	5	VII.	0	45	–	1	9	3	5	3	—	—	—	—	—	—	–	–	–	–	–	–	–	–	–	–	–	21
29	,,	,,	,,	IX.	1	0	–	—	11	48	19	21	4	4	8	1	—	—	–	–	–	–	–	–	–	–	–	–	–	116
30	,,	,,	23	VIII.	1	40	–	—	2	2	4	1	—	—	—	—	—	—	–	–	–	–	–	–	–	–	–	–	–	9
31	,,	Sept.	4	VII,	0	45	–	1	2	18	5	11	6	6	5	2	1	1	–	–	–	–	–	–	–	1	–	–	–	59
32	,,	,,	,,	VIII.	1	30	–	—	1	9	11	11	2	7	3	4	4	8	1	3	1	2	1	2	–	–	–	–	–	70

Total, 1902 .	679
,, 1901 .	1298
Grand Total .	1977

TABLE E.

Showing for each month—

(1) The total Plaice caught in each bay separately, distinguishing the four size-groups.
(2) The average size of Plaice caught (expressed in centimetres, with approximate equivalents in inches).
(3) The number of hours fishing.
(4) The catch of Plaice per hour's fishing.

I. START BAY.

Year.	Month.	No. of fish caught.				Total.	Average size.		No. of hours.		Catch per Hour.				
		0″–7″	8″–11″	12″–14″	15″+		cms.	ins.	hrs.	min.	0″–7″	8″–11″	12″–14″	15″+	Total.
1901	July	24	16	29	10	79	28·5	11¼	4	35	5·2	3·5	6·3	2·2	17·2
	Aug.	3	12	30	7	52	32·8	13	4	20	0·7	2·8	6·9	1·6	12·0
	Sept.	13	49	138	113	313	34·4	13½	14	15	0·9	3·4	9·7	7·9	21·9
	Oct.	6	87	210	131	434	34·2	13½	13	5	0·5	6·6	16·0	10·0	33·0
	Nov.	3	60	195	162	420	35·6	14	17	5	0·2	3·5	11·3	9·4	24·4
	Dec.	4	38	97	71	210	34·7	13¾	22	10	0·2	1·7	4·4	3·2	9·5
1902	Jan.	4	15	27	13	59	31·7	12½	7	45	0·5	1·9	3·5	1·7	7·6
	Feb.	8	26	10	12	56	28·8	11½	3	—	2·7	8·7	3·3	4·0	18·6
	April	13	13	28	21	75	31·1	12¼	7	10	1·8	1·8	3·9	2·9	10·5
	May	—	61	151	109	321	34·3	13½	18	15	—	3·3	8·3	6·0	17·6
	June	7	56	79	32	174	32·3	12½	6	30	1·1	8·6	12·2	4·9	26·8
	July	1	22	29	7	59	31·4	12½	6	30	0·1	3·4	4·4	1·1	9·0
	Aug.	10	169	112	53	344	30·0	11¾	10	45	0·9	15·7	10·4	4·9	32·0
	Oct.	—	8	4	4	16	31·8	12½	1	30	—	5·3	2·7	2·7	10·7
Totals .		96	632	1139	745	2612	—	—	136	55	14·8	70·2	103·3	62·5	250·8
Means (14 months)		6·8	45·1	81·3	53·2	186·57	32·24	12½	9	46	1·0	5·0	7·4	4·5	17·9
General averages		—	—	—	—	—	32·17	12½	—	—	0·7	4·6	8·3	5·4	19·0

TABLE E—*continued.*

II. TORBAY.

Year.	Month.	No. of fish caught.				Total.	Average size.		No. of hours.		Catch per Hour.				
		0″–7″	8″–11″	12″–14″	15″+		cms.	ins.	hrs.	min.	0″–7″	8″–11″	12″–14″	15″+	Total.
1901	July	43	27	20	3	93	22·3	8¾	2	50	15·2	9·5	7·0	1·0	32·9
	Aug.	7	6	12	4	29	27·3	10¾	1	5	6·5	5·5	11·1	3·7	26·9
	Sept.	143	78	49	16	286	20·4	8	5	—	28·6	15·7	9·8	3·2	57·2
	Oct.	130	64	40	28	262	21·5	8½	5	30	23·6	11·6	7·3	5·0	47·6
	Nov.	154	29	27	14	224	17·0	6¾	5	20	28·9	5·4	5·0	2·6	42·0
	Dec.	4	3	10	4	21	28·8	11½	2	45	1·0	1·5	3·6	1·5	7·6
1902	Jan.	37	4	5	2	48	18·0	7	1	45	21·1	2·3	2·8	1·1	27·4
	April	88	19	13	5	125	18·4	7¼	3	45	23·5	5·0	3·5	1·3	33·3
	May	—	2	4	2	8	33·1	13	1	40	—	1·2	2·4	1·2	4·8
	July	75	37	12	10	134	22·0	8¾	6	—	12·5	6·2	2·0	1·6	22·3
	Sept.	66	176	16	12	270	23·8	9½	3	45	17·6	46·9	4·2	3·2	72·0
Totals .		747	445	208	100	1500	—	—	39	25	178·5	110·8	58·7	25·4	374·0
Means (11 months)		67·9	40·4	18·9	9·09	136·36	23·0	9	3	35	16·22	10·07	5·33	2·31	34·0
General averages		—	—	—	—	—	19·95	7¾	—	—	18·95	11·28	5·27	2·58	38·01

III. TEIGNMOUTH BAY.

Year.	Mouth.	No. of fish caught.				Total.	Average size.		No. of hours.		Catch per Hour.				
		0″–7″	8″–11″	12″–14″	15″+		cms.	ins.	hrs.	min.	0″–7″	8″–11″	12″–14″	15″+	Total.
1901	Aug.	37	11	13	7	68	23·1	9	4	50	7·6	2·3	2·6	1·4	14·0
	Sept.	105	61	49	46	261	25·8	10¼	5	35	18·8	10·9	8·7	8·2	46·7
	Oct.	375	92	49	32	548	17·9	7	4	45	78·9	19·3	10·3	6·7	115·3
	Nov.	156	75	58	25	314	21·8	8½	6	35	23·7	11·3	8·8	3·8	47·7
	Dec.	94	7	3	3	107	14·8	5¾	4	30	20·9	1·5	·6	·6	23·7
1902	Jan.	78	3	4	4	89	14·8	5¾	2	15	34·7	1·3	1·7	1·7	39·5
	April	190	19	15	23	247	17·6	7	7	30	25·3	2·5	2·0	3·0	32·9
	May	1	21	16	7	45	31·1	12¼	7	—	—	3·0	2·3	1·0	6·4
	July	112	51	4	2	169	19·0	7½	5	55	18·9	8·7	·6	·3	28·5
	Sept.	47	51	20	11	129	24·6	9½	2	15	20·9	22·6	8·8	4·9	57·3
Totals .		1195	391	231	160	1977	—	—	51	10	249·7	83·4	46·4	31·6	412·0
Means (10 months)		119·5	39·1	23·1	16·0	197·7	21·07	8¼	5	7	24·97	8·34	4·64	3·16	41·2
General averages		—	—	—	—	—	20·14	8	—	—	23·35	7·64	4·51	3·12	38·6

APPENDIX I.

Preliminary Report on the Trawling Experiments in the Bays on the South Coast of Devon.

The investigation of the trawling grounds in Start Bay, Torbay, and Teignmouth Bay, which had been previously investigated in 1895–8 by Messrs. Stead and Holt, was resumed by the Marine Biological Associaton in 1901. The new investigations were placed in the hands of Dr. H. M. Kyle, Assistant Naturalist to the Association, and were carried out by him at nearly regular monthly intervals from the end of July, 1901, to the beginning of September, 1902, by means of the Association's s.s. *Oithona*.

In addition to the trawling investigations, Dr. Kyle arranged for the collection of special statistics dealing with the Brixham fisheries. These covered the period from the beginning of February, 1902, to the end of January of the current year.

The manuscript of Dr. Kyle's report was received in March, but the work of revision has been attended with considerable difficulty, owing to Dr. Kyle's removal to Copenhagen and the necessity of considerable correspondence. When it is mentioned that his report includes an analysis of nearly a hundred and fifty hauls of the trawl, in which every fish was counted and measured, and that elaborate calculations have been made from these data from a variety of points of view, it will be understood that the Council of the Association have felt the necessity of subjecting the work to a careful revision before transmitting a formal detailed report. As, however, there has already been some considerable delay, it is thought that the Devon Sea Fisheries Committee may be glad to receive a preliminary summary of the chief results of the investigation.

This summary is limited to questions affecting the plaice, except where otherwise stated.

Trawling Experiments in the Bays.

The new investigations confirm Mr. Holt's previous report on the following points:—

(1) Start Bay is not a nursery for small flat fish. Only 4 per cent. of the plaice caught were below 8 inches in length, while 71 per cent. of the plaice were 12 inches in length and over. This species matures at 11 inches.

(2) Teignmouth Bay and Torbay are nurseries for small plaice. In the former 61 per cent., and in the latter 50 per cent., were less than 8 inches in length. Three-quarters of the plaice in these bays were immature, and only 20 per cent. attained a length of 12 inches and over.

During the last year the preponderance of large fish over small in Start Bay, and of small fish over large in the other bays, was thus even more marked than during the previous investigations five years ago.

A remarkable feature of the bays last year, to which Dr. Kyle draws attention, was the relative scarcity of medium-sized plaice between 8 and 12 inches, as compared with the period covered by Mr. Holt's investigations. A discussion of the probable explanation of this feature must be reserved for the detailed report.

As was explained at the time of the commencement of the present investigations, no attempt could be made as a result of these experiments to provide a direct answer to any question as to the absolute increase or decrease in the abundance of fish on the grounds. The information provided by this report nevertheless points to distinct conclusions as to the probable effect of closure of the bays on the maintenance of the fishery as a whole.

Statistics of Fish landed.

Daily returns of the fish landed at Brixham by the small trawlers (Mumble Bees) have been provided by Mr. Will Sanders, the number of trunks being distinguished from the number of baskets. Dr. Kyle reports that the fishermen are accustomed to land their larger fish in the trunks and the small fish in the baskets. He considers that, generally speaking, the plaice above 11 inches are placed in the trunks, and those below that size in the baskets. He further estimates the average number of plaice in the trunks at about 90, and the average number of plaice in the baskets at about 25. From the returns provided by Mr. Sanders he has thus been able to obtain an approximate measure of the numbers of plaice above and below the limit of

11 inches landed by the Brixham smacks during the past year. He reports the total number of "large" plaice landed during the year as about 180,000. "Of this number more than half were captured during February, March, and April, when the plaice were spawning in the deep water, or returning to the inshore grounds after having spawned. The months when the larger fish are least abundant offshore are September, October, and November. It is worthy of remark that the numbers for the months rise from 360 in November to 49,860 in April, and descend again to 450 in October in an almost uniform manner."

"The number of small fish landed for the year is a little over 143,000. The total number of plaice, large and small, is about 323,000, and of these the small plaice amount to 44 per cent."

Dr. Kyle's comments on these figures may be here given. He says: "The most remarkable fact which this table reveals is the large number of small plaice which are captured in the deep water, not only in one month or season, but throughout the year. The largest number—that recorded in April—is 19,800, but those for the other months vary between 4,000 and 10,000."

It should be added that the fishing grounds from which these fish are derived lie almost entirely within the area Start Point to Portland, and that the landings are almost confined to those of the small trawlers (Mumble Bees), which are the chief fishing-boats on the grounds in question.

Experiments on Migration.

In order to trace the seasonal migrations of the plaice to and from the closed waters of the bays, Dr. Kyle marked nearly 500 fish with numbered labels of brass or bone, and liberated these partly in the inshore waters of each of the bays in October and November, 1901, and partly outside Torbay and Start Bay in April and May of the following year. A reward was offered and paid for every marked fish returned, and the greatest care was taken to obtain correct returns of the places where the fish were recaptured. The Association is again very greatly indebted to Messrs. Sanders for the efficient and friendly assistance which they rendered to Dr. Kyle in this respect. Thanks to their arrangements and to the friendly co-operation of the fishermen, more than 25 per cent. of the fish have been returned with reliable particulars of capture.

The results of the experiments show in a convincing manner that in November and December the great majority of the mature fish leave Start Bay for the deeper offshore waters in Lyme Bay, the larger fish taking a more or less direct course to the eastward, and the smaller ones a less direct course along the shallower gradients to the north-eastward, their general destination being towards the "Biscuit Dust" ground in the first case, and the so-called "Spion Kop" ground in the second.

From Teignmouth Bay the winter migration of the fish above 8 inches was also directed towards the northern of these areas, *i.e.* off Beer Head in about 20 fathoms; but the fish below 8 inches in length were found to remain for the most part in the bays until the following summer.

In March and April the Start Bay fish were found to be returning towards the bay from the distant grounds, where they had spawned, and were recovered within the limits in considerable numbers from July to October. They were recruited on their return journey by a majority of the fish liberated off the northern end of Torbay in May, which also tended to set into Start Bay during the autumn months.

As Dr. Kyle points out, these experiments confirm the view that Start Bay is essentially a summer and autumn "feeding ground" for the large plaice. It is neither a nursery for the small fish nor a spawning ground for the large ones, since the latter almost entirely desert the bay in winter on the approach of spawning time, and do not return until the spawning is over.

The Protection afforded by Closure of the Bays.

From the three classes of evidence briefly summarised above, it is clear that the closure of Start Bay to trawlers cannot materially protect the small fish (since the latter are present there in inappreciable numbers), nor can it furnish a sanctuary for the spawning fish, since the latter spawn mostly offshore. Its closure is therefore ineffective as a remedial measure, and merely delays the capture of the large fish a month or two longer than would otherwise be the case.

The closure of Torbay and Teignmouth Bay appears, on the other hand, to be advantageous so far as trawling is concerned, since these bays, especially the latter, contain the chief nurseries of small fish known within the entire area from Start Point to Portland, and the closure is not rendered ineffective by any natural tendency of the fish to emigrate in their earliest stages of growth. The extent, however, to which the prosecution of seine-fishing limits the efficiency of closure has not been further investigated.

WALTER GARSTANG,
Naturalist in Charge of Fishery Investigations.

PLYMOUTH, *July 7th*, 1903.

APPENDIX II.

Preliminary Report on Trawling Experiments in the Bays of South Devon.

SUMMARY TABLES (PLAICE).

SUBMITTED FOR THE INFORMATION OF THE DEVON SEA FISHERIES COMMITTEE.

TABLE I., *showing the Average Yearly Percentage Frequency of Plaice of different sizes in each of the Bays* (i.) *for* 1901–2, *and* (ii.) *for* 1895–8.

	Percentages.				Number Measured.
	0–7″	8–11″	12–14″	15″+	
Start Bay.					
1901 to 1902 . .	4	24	**44**	28	2,612
1894 to 1898 . .	12	**41**	38	9	1,636
Torbay.					
1901 to 1902 . .	**50**	30	14	6	1,500
1895 to 1898 . .	**39**	35	23	3	1,040
Teignmouth Bay.					
1901 to 1902 . .	**60**	20	12	8	1,977
1895 to 1898 . .	32	**56**	10	2	2,791

TABLE II., *showing the Average Quarterly Catch per Hour of Plaice of different sizes in each of the Bays* (*s.y.* "*Oithona*") *compared with the same for July*, 1895–8 (*s.y.* "*Busy Bee*").

A.—START BAY.

	Catch per Hour.					Percentages.			
Season	Total.	0–7″	8–11″	12–14″	15″+	0–7″	8–11″	12–14″	15″+
July to Sept., 1901 .	18	2	4	8	4	13	22	44	21
Oct. to Dec. ,, .	20	0·2	3	10	7	1	18	47	34
Jan. to Feb., 1902 .	11	1	4	4	2	10	36	32	22
April to June ,, .	18	1	4	8	5	4	23	45	28
July to Aug. ,, .	28	1	15	9	3	4	53	32	11
July, 1895–8, *Busy Bee*.	15	4	8	2	1	29	50	14	7

SUMMARY TABLES (PLAICE)—*continued.*

B.—TORBAY.

Season.	Catch per Hour.					Percentages.			
	Total.	0–7″	8–11″	12–14″	15″+	0–7″	8–11″	12–14″	15″+
July to Sept., 1901 .	45	15	14	11	5	33	32	24	11
Oct. to Dec. „ .	37	21	7	6	3	57	19	15	9
January, 1902 .	27	21	2	3	1	77	8	11	4
April to May „ .	25	17	4	3	1	66	16	13	5
July to Sept. „ .	51	18	27	3	3	35	53	7	5
July, 1895–8, *Busy Bee* .	45	11	28	4	2	24	63	9	4

C.—TEIGNMOUTH BAY.

Season.	Catch per Hour.					Percentages.			
	Total.	0–7″	8–11″	12–14″	15″+	0–7″	8–11″	12–14″	15″+
July to Sept., 1901 .	28	12	6	5	5	42	22	19	17
Oct. to Dec. „ .	61	39	11	7	4	65	18	11	6
January, 1902 .	40	35	1	2	2	88	3	5	4
April to June „ .	20	13	3	2	2	65	14	11	10
July to Sept. „ .	36	19	12	3	2	54	34	8	4
June, 1895–8, *Busy Bee* .						69	17	8	6

TABLE III., *showing Average Size of all Plaice caught during the Trawling Experiments in each Bay during* 1901–2.

Start Bay	12·8 inches.
Torbay	7·8 „
Teignmouth Bay	7·9 „

TABLE IV., *showing Percentage of Marked Plaice (exceeding* 8 *inches) recovered in the case of Teignmouth Bay and Start Bay Experiments.*

Liberated.		Recovered.	
Locality.	Number.	Altogether.	After 1 Year.
Teignmouth Bay . .	70	41 %	10 %
Start Bay . . .	258	23·5 %	1·5 %
Difference		17·5 %	8·5 %

NOTE.—The difference (17·5 per cent.) appears to represent approximately the proportion of Start Bay Plaice (large) which migrated outside the Brixham trawling grounds altogether.—W. G.

LOWESTOFT, *October* 5*th*, 1903.

Notes on the Physical Conditions existing within the Line from Start Point to Portland.

By

H. M. Kyle, D.Sc.

During the trawling work of the past year within and around the bays on the south coast of Devon, my attention was drawn to the peculiar phenomena displayed by the tides and currents in Start Bay, and a subsequent endeavour to trace their connections and consequences led to a wider survey of the region within the line from Start to Portland. The bottom samples brought up by the trawl and lead afforded excellent opportunities of ascertaining the nature and distribution of the different soils, and thus of tracing out their changes during the seasons. My own observations, moreover, were supplemented by those of the friendly Brixham fishermen, who had many years' experiences behind them. Their theories, it is true, were somewhat numerous and divergent, as becomes such an energetic and independent race, but the phenomena were described with a wonderful definiteness and unanimity. Knowledge of the bottom-soil—its changes through the month and year—and of the tidal phenomena is absolutely essential to the fisherman because his living depends upon it, so that one need not be surprised at, though appreciating, the great accuracy with which they can tell where they are and what they should catch in their trawls from a brief examination of the soil brought up by the lead.

In addition to the records of the trawl and lead, dredgings were taken in the usual manner by means of a canvas bag laced inside the ordinary dredge, but these were comparatively few in number. The region under investigation is an awkward one as regards weather even in the best of years, and the weather of the past year was exceptional in its severity. The result was that the limited time at our disposal was shortened on every occasion throughout the year, and the offshore grounds were only partially investigated. I am obliged, therefore, to rely on the Admiralty charts for the areas not investigated, but of the relations between tides and bottom-soil they, of course, give no account, and it is with these the present paper will deal.

In the various pilot guides to the English Channel a great amount of information is given with regard to the tides in the different regions, and much light is thrown on the circulation of the water within the line from Start Point to Portland and its relation to the tides at the mouth of the Channel; but here, again, the inshore currents are barely mentioned, and the relation of the currents generally to the formation and changes of the bottom-soil not at all.

Several papers contributed by Mr. H. N. Dickson to this Journal (vol. ii.) deal with the distribution of surface temperatures in the English Channel. Comparatively few records were taken within the area here considered, but during the summer of 1891 it was found that in Start Bay,* so called, a warm upper stratum of water was superposed upon a cold lower layer nearer the bottom. In other respects than temperature the two strata were alike. Special emphasis was laid by Dickson upon this discovery, even though observations made in the succeeding winter failed to corroborate it. It showed that the colder waters from west of the Start were able to penetrate under the almost stagnant upper layers within the Great West Bay.

With regard to the action of waves and currents on the shore a great deal of literature exists, but it is unnecessary to enter into this aspect in any detail. Reference need only be made to the paper of Vaughan Cornish on the famous Chesil Beach near Portland, and to the recent work of Wheeler on the *Sea Coast: Its Destruction and Protection.* In the former the much-disputed origin of the Chesil Beach is discussed, and a theory stated which seems to accord well with the phenomena observed. As will be shown later, this theory is accepted here and applied to phenomena very similar, though on a smaller scale, at the other extreme of the area, namely, Slapton Sands in Start Bay. In the latter work an interesting account is given of the actual condition of the shores and the littoral drift on the south coast. Reference will be made to it later.

The Great West Bay is 48 miles across from Start Point to Portland, and extends 20 miles inwards. Its area is about 650 square miles. It opens to the south-west, so that its easterly arm towards Portland is fully exposed to the southerly and westerly gales, but sheltered from the easterly. Conversely, the arm which extends out to the Start is sheltered from the westerly gales, and only the easterly and south-easterly winds affect it strongly.

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* Considerable doubt exists as to the right name to apply to the region within the line from Start Point to Portland. Dickson refers to it as Start Bay, but this is obviously incorrect. Wheeler calls it Lyme Bay, but Lyme Bay is more usually restricted to the northern portion from Hope's Nose or Straight Point to Portland. It seems advisable to have a distinct name, however, because Start Point and Portland form the natural boundaries to a compact series of phenomena, and the name Great West Bay, used by Mr. A. R. Hunt (*The Evidence of the Skerries Shoal on the Wearing of Fine Sand by Waves*, 1897), has been adopted in this paper.

It has long been known as a good fishing-ground, and at the present day from seventy to eighty of the Brixham boats trawl over it regularly throughout the year. From the point of view of the fisheries this area is of great interest, for it displays within comparatively narrow limits all the important biological problems in connection with the life histories of food-fishes, as well as the physical conditions with which those life histories are so closely related.

Tides and Currents.

The movements of the tides in the English Channel are complicated by the numerous bays and inlets of the French and English coasts. In the centre of the Channel the periodic ebb and flow is fairly regular, but even there the cross currents caused by in-draughts into the various bays on both coasts produce a rotary motion at the changes of the tides, which is only approximately constant as regards direction and duration. Without entering too far into the details which may be found in Channel pilot books, the tidal currents and their strengths may be referred to so far as they concern the Great West Bay.

The Channel is divided into three main regions: the first lies to the west of the Lizard in Cornwall; the second from the Lizard to Start Point; and the third from Start Point to Beachy Head. In the first division the state of the tides is always the reverse of that in the third, *i.e.* with regard to ebb and flood; in the second region it is "intermediate," agreeing for one half of the tidal period with the outside main tidal stream, and for the other half with the "true Channel stream" between Start Point and Beachy Head. There is no definite line of demarcation, however; what happens is that whilst the "true Channel stream" is flowing, the condition intermediate between ebb and flood, *i.e.* slack water, is gradually passing from the Lizard to the Start until it reaches the latter point two hours before high water at Dover. To the west of Start Point, therefore, the ebb is going to the west for one hour whilst the flood to the east of Start Point is still travelling to the east. The "true Channel stream," as is well known, suddenly changes after high water at Dover throughout the third region and ebbs to the west. For the short space of one hour the direction of the tidal current is the same throughout the entire Channel, *i.e.* to the west, then the flood begins to make at the western end, and for the next four hours the second region is the centre of opposing forces. In the western end of the Channel the flood is deflected to the north for one hour, and then flows steadily to the east; in the centre of the second region the antagonistic forces produce a definite spell of slack water when they meet, but in the eastern end near Start Point the oncoming flood is deflected to the south and south-east for two hours before it is able to overcome the opposing ebb current. During the same period the ebb to the east of the Start is deflected first of all to the south of west, then to the north, and there is no period of slack water. During the last part of the ebb, therefore, the tidal current is setting directly into the Great West Bay.

It thus appears that the Great West Bay participates in the effects of the conflict between the "true Channel stream," and the "intermediate stream," and these effects are such that a definite spell of slack water occurs on the last of the flood,* and that there is an inset on the last of the ebb.† It is evident, therefore, that these conflicting currents tend on the whole to weaken the tides in the Great West Bay, and the peculiar disposition of the bottom-soil there is in part due to this cause.

The strength of the tidal currents is manifested by the rate. Whilst the rate outside is over two knots per hour at springs, within the Great West Bay, off Berry Head, it is less than one knot. The centre of this region, in fact, is almost at rest so far as the tides are concerned, and farther in towards the land, off Beer Head, the currents move definitely round a complete circle during the tidal period.

At the two extreme corners the currents rush in and out with great velocity. The latter phenomenon is associated with, and partly the result of, the heaping up of the waters within a confined area. When the flood-tide passes round the Start it has to contend against not merely the rising ground, but also a sheet of water which will stand compression only to a limited extent. The main stream is consequently deflected away from the bay towards Portland. For the first three hours of flood the water-level steadily rises all over the area, and the trend of the current all along the shore is towards the east. When high water is reached the current is still eastward outside and in the easterly portion of Lyme Bay, but as we pass in towards the land of the westerly portion, the current gradually gets slower, until it ceases altogether, and finally changes its direction and flows to the west. The waters heaped up at the head of the bay by the rising tide must find some outlet after high water, and whilst the eastward current outside has still some three hours to run. As we pass, on the one hand, from Beer towards Portland, the stream gradually increases from almost nothing in strength to over five knots per hour. As we pass backward along shore from Beer towards the Start we pass through Teignmouth Bay, where the current is scarcely felt, Torbay, where it is uncertain and variable in direction, until we come to Berry Head and Mudstone Ledge, where the current is setting to the westward.

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* Except, perhaps, to the east of the bay, near Portland.

† The direction of the surface currents here, as elsewhere in the English Channel, is greatly determined by the prevailing winds. Cf. W. Garstang, *Journ. M. B. A.*, v. p. 199.

On the shore of the western half of the area there is, therefore, a backward eddy during the latter half of the flood-tide. Wheeler, in describing this peculiar phenomenon for Start Bay, imagined that the flood-tide was deflected from the cliffs forming the north-eastern boundary of Start Bay, and thus entered the bay from its north-eastern aspect. Apart from the inherent improbability of such a thing, this explanation leaves out of count the presence of the backward eddy over Mudstone Ledge close to Berry Head.

Along Slapton Sands, in Start Bay, the current sets towards Start Point the last half of the flood and the whole of the ebb, *i.e.* for nine hours out of the twelve. Along Chesil Beach, at the other corner, the current sets towards Portland also for nine hours out of twelve, but there it is during the last part of the ebb and the whole of the flood.

The tidal phenomena close to Portland repeat what has already been described as occurring off Beer Head. Two miles west of Portland Bill the direction of the currents turns round a complete circle, so that after three hours of ebb-tide the current sets northerly into the bay, and to counterbalance this inset there is an outward eddy along Chesil Beach. This northerly set of the current is probably due to the fact that the flood is already making to the west of Start Point. To the west of Portland Bill, therefore, there is a circular motion of the waters during the last part of the ebb.

The comparison of the currents at the two extreme ends of the area may be carried still farther. At the eastern end the stream passing round Portland Bill meets with an opposing ebb and eddy from beyond, and thus helps to form the "race," which passes on to and over the great sandbank known as the Shambles. At the western extremity the eddy issuing from Start Bay also forms a race with the opposing flood-tide coming from the west, and this race extends obliquely from the shore for nearly a mile in a south-westerly direction. The outgoing eddy, however, is weak in comparison with that at Portland, so that the race is not a strong one, and the sandbank, instead of being in the direct line of the race, lies farther to the north-east on the line of the flood-tide.

The conditions, so far described, obtain generally throughout the year, but are more particularly marked during spring-tides. During neaps, the water is almost stagnant over the whole western area, and the currents along shore are feeble and uncertain in direction. In Teignmouth

Bay there is practically no current one mile from the shore. The tide sets directly on to the beach in its northerly portion, and the only currents along shore are caused by projecting headlands, *e.g.* Clerk Point, sending off the incoming tide on each side in different directions. At the southern end of the bay the incoming tide sets along the projecting headland of Hope's Nose, and there is thus a slight current along shore.* In Torbay the central portions are even more stagnant than in Teignmouth Bay, but on the beach we have the same phenomenon of currents acting in opposite directions. Paignton Head, in the centre of the bay, divides up the incoming tide, and there is a current on each side of it—the one tending across Brixham breakwater to Berry Head, the other towards Torquay and Hope's Nose.

Sometimes, as the result of storms either within the area or beyond in the Channel, these currents may be reversed, but in general they are well marked.

Within Start Bay during neaps there is very little current in the centre of the bay, and the eddy along shore is not so strong as during spring-tides. During the latter periods the eddy rushes out round the Start at a rate exceeding two knots per hour. This eddy extends about a mile from the shore off Torcross, and during the ebb the current sets straight across the Skerries in a south-south-easterly direction.

Depths and Bottom-soil.

The region under consideration lies mostly within the thirty-fathom line. At Start Point the water deepens rapidly, so that within two miles of the shore thirty fathoms is reached. From there the thirty-fathom line runs in an easterly direction until the centre of the bay is reached, when it inclines to the south of east and passes Portland about eight miles off. Within this line the water gradually shoals, and twenty fathoms is reached on a line from Berry Head to Portland. The twenty-fathom line is also concave, with the concavity more marked towards Portland. The ten-fathom line follows roughly across the outlying headlands of the numerous bays and indentations round the coast, being nowhere more than three miles from the shore, and in some places approaching it to within a few yards.

The general rise in the bottom-level is fairly uniform and regular, except along the western side, where important modifications occur. Within half a mile of Start Point, to the north-east, the water shoals rapidly from nine fathoms to four, and a little farther to only two.

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* According to Mr. Taverner, the Fisheries Inspector of the Devon Sea Fisheries Committee, the general trend of the current here is from Babbacombe towards Hope's Nose; that is to say, that the eddy which makes itself so evident in Start Bay is already felt in Teignmouth Bay.

From thence the sandbanks of the Skerries extend in a north-easterly direction for three miles. The tops of the banks lie from two to five fathoms below the surface, but between them the water deepens to nine or more fathoms. On the outer side the slope of the banks is very steep, and more so toward the end away from the Start. In some places it descends from five fathoms to eighteen within a hundred yards. On the inner side the slope is more gradual, but when from four to five fathoms are reached there is a sudden dip down to about seven. This is caused by the central channel of the bay, which narrows as it approaches the Start, and is generally about nine fathoms deep. Half a mile off Hallsands, in June, 1902, a depth of fifteen fathoms was obtained by the lead, and according to the Brixham fishermen this part is "full of pits."

At the other extremity of the Skerries Bank there is a sudden dip to fourteen fathoms at the Bell Buoy, and from there across to the Mewstone, on the far side of Dartmouth fairway, the depth approaches twenty fathoms. Beyond the east Blackstone, half a mile to the east of the Mewstone, there is a bank of sand well known to the Brixham men, but not clearly indicated on the charts. It begins on the southerly aspect of the Blackstone, and runs in a north-easterly direction for nearly a mile. The depth of water over it varies from ten to fifteen fathoms, but, like the Skerries, there are depressions at various places. Immediately inside it the depth varies from thirteen to eighteen fathoms. The presence of this bank is of great interest, and the water over it almost always displays some disturbance.

As we pass towards Berry Head we find a deep channel within half a mile from the shore. On one occasion during May, 1902, a depth of thirty fathoms was recorded a quarter of a mile off the Cod Rock. The greatest depth given by any chart for this place is twenty-eight fathoms, and the Admiralty charts give only twenty-three. Outside the channel the depth of water is but seventeen to nineteen fathoms. Apart from these exceptions, the depths given by the Admiralty charts were found to agree fairly well with the records.

The soil in the Great West Bay varies from rough gravel and stones to fine sand and mud. Along the thirty-fathom line we find for the most part gravel and coarse sand, except at the two extremes. Five to six miles off the Start in an easterly direction, with Prawle Point on a line with the Start, there are banks of fine sand, which in the beginning of summer are covered by mud. This region is called the "Corner" by the Brixham fishermen, and, it will be noticed, lies straight off Dartmouth fairway. The depth over these banks is about thirty fathoms, and they are surrounded by water one to two fathoms deeper.*

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* These banks are not to be confounded with Start Bank, which lies to the south of Start Point. See chart.

As we pass along the thirty-fathom line and come to a point east by south of Berry Head, and south-west of Portland, we meet with a long bank or ridge of gravel, shells, and stones, which extends on to the rocks off Portland. This ridge is not shown on the smaller charts, but on the large chart of the Channel by Laurie it is significantly marked as "rotten ground," "coarse," and "sand and small stones." The first designation probably refers to the oyster and pecten shells which abound there in great quantities. The Brixham men call the ridge the "Scruff," and state that there used to be a western scruff of similar material in the Corner off the Start. The western limit of the Scruff is not clearly defined, but there is a break between it and what are called the "Clumps," the rough ground about fifteen to twenty miles off the Start. The Scruff and the Clumps are, however, of similar nature, and if we continue the same line westward we come upon the rough stony tract which forms the centre of the Channel.

The breadth of the Scruff seems to be about a quarter of a mile. Its outer boundary is parallel and close to the line followed by steamers passing up and down Channel from Portland to the Start. Within the line of the Scruff there is a broad band of bright yellow sand of medium to coarse quality, which the trawlers call "biscuit dust." This extends as far as the twenty-five-fathom line, where it changes to fine sand of a brown colour. This continues all round Lyme Bay until fifteen to sixteen fathoms are reached, when it gives place to rocky ground with intermediate patches of sand.

The western side of the Great West Bay is just the reverse of the eastern. Outside the Skerries we find gravel and coarse sand, but from there onward to off Teignmouth Bay the offshore grounds consist of fine sand and mud. This, in fact, is the peculiarity of the western part, that its central region, from twenty-seven fathoms right into Torbay, consists of mud (Tables I. and II., p. 540, Sample x.). There is no place in the English Channel, nor, so far as I can discover, round the British coasts, where mud—non-estuarine in character—has accumulated to such an extent as off Berry Head.

Within Start Bay, and along a narrow strip from Berry Head to the Mewstone off Dartmouth, the bottom-soil is quite different. Gravel and coarse to medium sand are found between the rocks off Downend, and on the bank off the East Blackstone. There is a tract of mud across the mouth of the Dart until we come to the centre of Start Bay off Torcross. The mud then gives place to fine yellow sand, and this, towards the shore on the one hand and the Skerries on the other, grades into coarse sand. Along the beach from Blackpool to Start Point the soil gradually changes from medium sand, through mixed sand and stones on Slapton beach, to a fairly uniform spread of gravel and pebbles at Hallsands.

A dredging obtained off Blackpool, where the beach is of sand, showed that other materials were present in the deeper waters. It is well known that the sand of the beach rests on a clay bottom, which is frequently uncovered by storms. At the eastern corner, in five fathoms of water, this clay was found free of sand, but contained small pebbles similar to those on the beach at Hallsands. These pebbles were well rounded, showing that they must have travelled about a good deal until trapped in the clay.

Apart from the beach the coarsest sand in Start Bay is to be found along the margins of the Skerries Bank. Samples obtained there after a gale from the east on the 4th February, 1902, showed that the material varied from coarse gravel to fine sand, stones being absent, and silt practically so (Tables I. and II., Samples ii.–vi.).* Of five samples taken the coarsest was 4·760 on the average, or between coarse sand and fine gravel, whilst the finest was 6·049, *i.e.* medium sand. The finest material obtained on that date was 6·86 on the average, *i.e.* almost entirely fine sand (Sample vii.), and this was got, not on the Skerries Bank, but half a mile from the shore between Hallsands and Beesands. In the summer and autumn, however, the fine sand is found on the top of the Skerries Bank, and the easterly gale is responsible for its having been found within the bay near the shore.

Off Teignmouth Bay, again, we find a peculiar distribution of the bottom-soil. From Hope's Nose to off Teignmouth there is a stretch of hard ground on which oysters are fairly abundant. As showing the trend of the current in Teignmouth Bay, it may be mentioned that the empty shells congregate in masses behind the Orestone on the Torbay side. Outside this hard though muddy ground, there is a long shelving bank, which the Brixham fishermen call the "Ledge." This extends out in an easterly direction, and has several patches of rocks and coarse gravel. On the inner side of the oyster ground lies a stretch of muddy ground, which, within six fathoms, gives place to sand. The ground on the northern portion of the bay is very variable throughout the year. When first worked over during the autumn of 1901, it was a stretch of uniform sand from off Teignmouth to the fairway buoy off Exmouth; but in the spring of 1902 the sand was swept away, and a bed of large stones running out from Clerk Rock to over a mile from the shore was laid bare. This bed was still uncovered in July, 1902.

It only remains now to consider the relations between the tides and currents on the one hand, and the bottom-soil on the other. The effect of storms is to disturb the actual condition of things, but with fairly regular currents the tendency of soil is to take up a state of equilibrium so that one kind is present at one place and others at another. Looking at the matter broadly, we may say that wherever a current is running we find stones, but where there is comparative calm we find sand or mud.

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* The grading of the soil is as given by E. J. Allen, "On the Fauna and Bottom-deposits near the Thirty-fathom Line from the Eddystone to Start Point" (*Jour. M. B. A.*, vol. v. p. 378).

It has been shown that the Great West Bay is the centre of reciprocating currents in the Channel; further, that the main tidal stream does not penetrate far into the bay, and consequently that the current inside is less than one knot per hour at full and change of moon, whereas outside it is over two. These causes combined bring about a state of comparative calm within the bay, more especially to the westward side and in the centre, and it is there we find the finest bottom-soil of the whole region.

At the head of the bay, *i.e.* off Beer Head, it was pointed out that the tides set round a complete circle within the twelve hours, and the tendency of the currents, therefore, is to carry away from this centre whatever material may be movable. We thus find that along the northern shore the ascent to the beach is comparatively rapid, *i.e.* deep water approaches close to the shore, and, secondly, that the ground is mostly hard and rocky, with a few patches of mud and sand between the rocks.

As we pass from the head of the bay along its two arms, it has been shown that we meet with two currents, which gradually increase in velocity and strength as they approach and finally pass round the two extreme points. On the one hand, at Portland this current is made up of the flood-tide and an eddy from the ebb, and is of great velocity—greater than the outside main tidal stream; on the other hand, at Start Point the current arises from the ebb-tide and an eddy from the flood, and is comparatively weak. Both these currents flow in their respective directions nine hours out of the twelve, and their constancy and duration are considered to be due to the heaping up of the waters by the tide at the head of the bay.

On the eastern arm towards Portland there can be little doubt that the east-going stream has considerable influence in keeping the bottom clear of sand and mud, and thus leaves the rocks bare and uncovered. Along this arm the rocks of the coast project outwards as far as the fifteen-fathom line. The seas raised by the gales from the south and south-west break heavily on this eastern arm, but their influence is mostly destructive, and the sand and mud would tend to return to their former position were it not for the steady, though at the beginning slow, current which is in reality the effective agent in the transference of sand from west to east. It is to the excess of the easterly-going current over that going to the west that Vaughan Cornish * ascribes the peculiar formation of the famous Chesil Beach. As is well known, this beach begins near Bridport with fine sand and extends a distance of sixteen miles towards Portland, the sand gradually changing to gravel and pebbles and thence to stones. The grading is so nice that fishermen are said to be able to tell where they are, even in the dark, by merely examining the materials of the beach. According to Cornish, the east-going current of nine hours' duration is able to carry along materials to a greater distance than the west-going current of only three hours. Consequently the heavy stones are steadily being carried to the eastward, until they are trapped by the projecting "island" of Portland, which acts as a natural groyne. The lighter materials remain longer in suspension and are carried onwards beyond the Bill to the Shambles. The west-going stream may carry the suspended sand backwards towards Bridport, but on the whole the drift is easterly.*

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* "The Grading of the Chesil Beach Shingle" (*Proc. Dorset Nat. Hist. Field Club*, 1898).

It has been mentioned that a returning eddy makes its appearance in Start Bay after high water by the shore, and though this eddy has not been definitely traced farther back than Berry Head, there are indications of its presence even in Teignmouth Bay. In the centre of the latter bay the tides are scarcely felt, and the trend of the currents on the shore is in opposite directions at Teignmouth and Exmouth. The former seems to be due to the returning eddy, which, though weak, tends to deaden the flood-tide, whilst the latter is due in part to the conjoined currents setting directly on to the shore. At the lower end of the bay we have clearer evidence of the eddy in the strong current which rushes through between the Orestone and the mainland on the ebb, and in the accumulation of material from Teignmouth Bay on the Torbay side of the Orestone.† In Torbay itself the only evidence I have found for the presence of the eddy is that the trend of objects from the Brixham side of the bay is past the breakwater and on to Berry Head. Off Berry Head we have the deep, though narrow, channel close in to land, which seems unmistakable evidence of a strong eddy, and over Mudstone Ledge the eddy definitely makes it appearance. Off Downend, again, we find a sandbank separated from the land by a deeper channel, which has probably been formed by the conflict of the flood-tide flowing easterly on the outside with the eddy going to the west on the inside. Lastly, the whole appearance of Start Bay is evidence of the presence and great influence of the eddy.

On the chart it will be noticed that the depth contour lines in Start

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* According to Wheeler (*loc. cit.*) there is also a distinct northerly current flowing along the island, and this accounts for the greater accumulation of material at Chesilton, which lies at the bend where the island begins to separate from Chesil Beach.

† See foot-note, p. 533.

Bay are just the reverse of those in other parts, *i.e.* they are opposed to the direction of the flood-tide. The opening into the bay lies between the Skerries Buoy and the Mewstone, whilst its head is at Hallsands. This shows that the currents in the bay tend in the main to go from the Dartmouth end towards the Start. The presence of the Skerries Bank undoubtedly has a great deal to do with the opening of the bay from the north-east, but it seems clear that this bank must itself have been formed under the influence of the eddy. Since the latter is running down through Start Bay for nine hours out of twelve, it follows that for three hours out of twelve it is opposing the oncoming flood-tide off the Start, and the materials it is carrying down in suspension eventually come to rest either on the beach or along the line of demarcation. This seems to explain clearly enough why the Skerries Bank is present off Start Bay, and also why it is broader near the Start than at the other end near the buoy. The tendency is for the sand to accumulate more and more at the south-west corner, because it is there that the opposing currents meet and are most in conflict, causing the water to be comparatively calm, and it is only the deep channel cut out by the eddy between the bank and the land which prevents the south-west corner from being filled up by sand.

Along the beach from Slapton to Hallsands we have the Chesil Beach reproduced on a smaller scale. The finer sand mixed with stones and gravel is found on Slapton Sands, whereas at Hallsands there is practically nothing but pebbles. The theory of Cornish seems to apply equally well here. The eddy and the ebb together being in excess of the flood, carry all materials down the bay. The heavier stuff comes to rest sooner under the lee of the projecting promontory of Start Point, and is thus deposited on the beach at Hallsands, whilst the lighter sand is carried onwards and deposited on the Skerries.

In conclusion, the comparison between Chesil Beach and the beach in Start Bay may be recapitulated. In both cases we have currents flowing for nine hours one way and three hours the other, a projecting promontory at each which acts as a natural groyne, a grading of the beach materials from fine to coarse in the direction of the more prolonged current, and the presence of a large sandbank offshore. Further, both beaches have been raised in great part, if not entirely, by the action of these currents, and a stretch of water has thereby been enclosed—in the one case Slapton Ley, behind Slapton Sands, in Start Bay; in the other case the Fleet, near Portland.

When more samples of the bottom-soil have been obtained it will be possible to push the comparison still farther.

I. SAMPLES OF THE BOTTOM-SOIL, SHOWING THE PROPORTIONS OF THE DIFFERENT KINDS OF SAND.

SAMPLES.

GRADE.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
I. Stones . .	...	...	...	...	...	...	...	...	...	...
II. Coarse Gravel .	...	0·50	0·58	0·70	4·30	0·37	0·25	trace	3·20	...
III. Medium Gravel	1·35	2·60	3·10	2·40	15·60	2·71	0·10	0·42	5·50	1·4
IV. Fine Gravel .	3·50	4·00	7·92	4·50	21·00	4·61	0·20	1·65	11·20	·68
V. Coarse Sand .	4·45	5·80	10·25	5·30	19·20	6·30	0·25	2·37	12·30	·78
VI. Medium Sand .	59·70	80·30	71·85	70·50	38·20	56·00	11·05	61·14	50·50	16·0
VII. Fine Sand .	...	6·80	6·30	16·60	1·70	30·01	87·80	34·41	17·30	74·0
VIII. Silt . .	...	trace	...	...	trace	trace	0·35	trace	trace	7·2

NOTE.—I am much indebted to Mr. R. H. Worth for kindly working out Samples II. to VIII.

II. GROUND WHERE SAMPLES WERE OBTAINED AND AVERAGE CONDITION OF SAMPLES.

No.	Ground, Depth, and Date.	Average.
I.	Close to Skerries Buoy on inner side ; 11½ fathoms ; January 30, 1902	6·22
II.	Close to Skerries Buoy on inner side, after easterly gale ; 12¾ fathoms ; February 4, 1902	5·83
III.	Close to Skerries Buoy on outer side ; 15 fathoms ; February 4, 1902	5·686
IV.	On line Skerries Buoy to Start Lighthouse (½ mile) ; 10 fathoms ; February 4, 1902	5·923
V.	On line Skerries Buoy to Lighthouse (half-way) ; 10 fathoms ; February 4, 1902	4·760
VI.	South-west corner of Skerries Bank, opposite Hallsands, on line Buoy to Lighthouse ; 10 fathoms ; February 4, 1902 . .	6·049
VII.	Midway between Hallsands and Beesands (½ mile offshore) ; 9½ fathoms ; February 4, 1902	6·86
VIII.	Off Torcross (2 miles) ; 7½ fathoms ; February 4, 1902 . . .	6·274
IX.	On line Skerries Buoy to Lighthouse (¾ mile) ; 16 fathoms ; February 4, 1902	5·513
X.	Four miles off Berry Head (E. ½ S.) ; 24 fathoms ; April 16, 1902 .	6·82

Notes on the Invertebrate Fauna and Fish-food of the Bays between the Start and Exmouth.

By

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Introduction.

The following records are based on notes taken on board the *Oithona* when engaged in fishing in the bays. Whilst the primary object of the work was the distribution of fish, it was thought that something would be gained if the distribution of the invertebrates in the same area were known. The time at our disposal, however, did not allow of hauls with the dredge and shrimp trawl, so that the records are based, in all but one case, on the invertebrates caught in an otter trawl, the exception being on the Limpet Rocks off Torcross, where one haul with the dredge was taken. This is accountable for the fact that many of the smaller invertebrates were not caught at all, whilst some are only recorded because they were found in fish stomachs. The almost total absence in the records of Tunicata, Polyzoa, and small species of the other groups is due to the fact that only those were recorded which could be identified on board. The records themselves, however, incomplete as they are, are fairly representative of the distribution of the species recorded.

For a description of the bottom-deposits and the positions of the stations worked over, the reader is referred to the Report to the Devon Committee in the present number of this Journal, pp. 451, 460, 467.

I. Records of Invertebrates.

START BAY.

Station I.

This ground was characterised by the presence in moderate numbers of *Chætopterus variopedatus* and *Atelecyclus heterodon*, the latter of which occurred on only one other ground, "the Corner," where it was common. *Maia squinado*, *Corystes cassivelaunus*, and *Solen ensis*, the latter in Plaice stomachs, were more common on this ground than elsewhere.

Other common species were *Eupagurus Bernhardus* and *E. Prideauxii*, with their attendant anemones *Sagartia parasitica* and *Adamsia palliata*, these being especially abundant, and also *Astropecten irregularis*, *Asterias rubens*, *Portunus depurator*, *Pecten opercularis*, *Solen pellucidus*, and *Syndosmya alba*, the two latter being taken in Plaice and Dab stomachs.

Soil, fine sand and mud; depth, 9–20 fathoms.

List of Species.*

HYDROZOA.

Hydractinia echinata. Not uncommon.
Obelia longissima. Dead; taken once.
Campanularia verticillata. Taken once.
Sertularella Gayi. Taken once.
„ polyzonias. Taken once.
Sertularia operculata. Taken once.
Sertularia abietina. Common.
Hydrallmania falcata. Moderately common.
Antennularia antennina. Taken once.
„ ramosa. Occasionally taken.

ACTINOZOA.

Alcyonium digitatum. Occasional.
Sagartia parasitica. Common with E. Bernhardus.
Adamsia palliata. Common with E. Prideauxii.

ECHINODERMA.

Astropecten irregularis. Common.
Asterias rubens. Common.
Ophiura ciliaris. Taken occasionally.
Echinus miliaris. Taken occasionally.
Spatangus purpureus. Fragment only.
Echinocardium cordatum. Occasionally.

POLYCHÆTA.

Aphrodite aculeata (*Linn.*). Not uncommon.
Acholöe astericola (*Clpd.*). Taken once.
Chætopterus variopedatus (*Clpd.*). Not uncommon.

CRUSTACEA

Maia squinado. Very common.
Eurynome aspera. Taken once.
Cancer pagurus. Taken occasionally.
Portunus puber. Taken once.
„ depurator. Common.
„ holsatus. Occasionally.
Polybius Henslowii. One ♂ taken.
Gonoplax angulatum. One taken from Thornback stomach.
Atelecyclus heterodon. Moderately common.
Corystes cassivelaunus. Common.
Eupagurus Bernhardus. Very common.
„ Prideauxii. Very common.
Porcellana longicornis.
Palinurus vulgaris. One.
Homarus vulgaris. One.

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* The following is the nomenclature used throughout:—

Hydrozoa. Hincks, *British Hydroid Zoophytes.*
Actinozoa. Gosse, *The British Sea-anemones and Corals.*
Echinoderma. Bell, *Catalogue of British Echinoderms in the British Museum.*
Crustacea. Bell, *British Stalk-eyed Crustacea.*
Mollusca. Forbes and Hanley, *British Mollusca.*
Polyzoa. Hincks, *British Marine Polyzoa.*
Tunicata. Herdman, *A Revised Classification of the Tunicata.* Linn. Soc. Jour., xxiii.

MOLLUSCA.

Corbula gibba. One in Plaice stomach.
Solen ensis. Moderately common in Sole and Plaice stomachs.
Solen pellucidus. Moderately common in Sole and Plaice stomachs.
Syndosmya alba. Common in Dab and occasionally in Plaice stomachs.
Mactra solida. In Dab stomachs.
Lutraria elliptica. Shells only.
Cardium aculeatum. Shells only.
Pecten opercularis. Common in Dab stomachs.
Natica monilifera. Shells very common; two alive.
Natica nitida. Occasional.
Buccinum undatum. Occasional.
Philine aperta. Occasional.
Loligo media. Moderately common.
Sepia officinalis. Moderately common.
,, elegans. Occasional.

STATION II.

This ground was not particularly rich, *Portunus depurator* being the only species which was at all common. *Peachia triphylla,* of which two specimens were taken, deserves mention on account of its rarity.

Soil, coarse sand; depth, 5–7 fathoms.

List of Species.

HYDROZOA.

Sertularella polyzonias. Occasionally.
Sertularia abietina. Occasionally.
Hydrallmania falcata. Occasionally.

ACTINOZOA.

Peachia triphylla. Two only.
Sagartia parasitica. Not uncommon.
Adamsia palliata. Not uncommon.

ECHINODERMA.

Astropecten irregularis. Moderately common.
Asterias rubens. Moderately common.

POLYCHÆTA.

Aphrodite aculeata. Not uncommon.

CRUSTACEA.

Maia squinado. Not uncommon.
Portunus depurator. Common.
,, holsatus. Not uncommon.
Eupagurus Bernhardus. Not uncommon.
Eupagurus Prideauxii. Not uncommon.
Solen pellucidus. In fish stomachs.
Syndosmya alba. In fish stomachs.

MOLLUSCA.

Mactra solida. In stomachs of *Callionymus.*
Cardium aculeatum. Shells only.
Nucula nitida. In stomachs of *Callionymus.*
Pecten opercularis. Occasionally.
Rissoa parva. Taken once.
Natica monilifera. Shells only.
Nassa incrassata. In stomach of *Callionymus.*
Buccinum undatum. Not uncommon.
Philine aperta. Taken once.

STATION III.

The Skerries Bank, scoured as it is by strong currents and disturbed by the heavy seas which sweep over it during gales from the N.E. round by S. to S.W., has a fauna which is not well represented in catches made with an otter-trawl. In fact, some hauls made on it did not give more than two or three invertebrates altogether. Echinoderms, other than *Echinocyamus pusillus*, which was taken from the stomachs of Plaice caught on the bank, were altogether absent, and the only living molluscs taken were *Dendronotus arborescens* and *Æolis papillosa*, both of which were found on an old crab-pot. It, however, is one of the chief grounds on which the edible crab, *Cancer pagurus*, is taken in the neighbourhood. Besides *Cancer*, the only other common species are *Portunus depurator* and *Maia squinado*. *Gastrosaccus spinifer* was, however, very common in the stomachs of *Raia blanda*, but no living specimens were taken in the trawl, due doubtless to the size of the mesh, and this is probably accountable for the absence in the records of such forms as shrimps, pandalids, etc.

Soil, coarse sand; depth, 3–18 fathoms.

List of Species.

ACTINOZOA.

Sagartia parasitica. Occasional.
,, viduata. A dozen on an old crab-pot.
Adamsia palliata. Occasionally.

ECHINODERMA.

Echinocyamus pusillus. Common in Dab stomachs.

HIRUDINEA.

Pontobdella muricata (*Linn.*).

CRUSTACEA.

Maia squinado. Common.
Cancer pagurus. Common.
Portunus depurator. Moderately common.
,, holsatus. One in stomach of *Acanthias*.
Eupagurus Bernhardus. Occasionally.
,, Prideauxii. Occasionally.
Gastrosaccus spinifer. Very common in stomachs of *Raia blanda*.

PYCNOGONIDA.

Pycnogonum littorale. Two on an old crab-pot.

MOLLUSCA.

Mactra solida. In stomach of *Callionymus*.
Natica monilifera. Shells.
Dendronotus arborescens. A dozen on an old crab-pot.
Æolis papillosa. Two or three on an old crab-pot.

POLYZOA.

Cellaria fistulosa. Taken once.

LIMPET ROCKS OFF TORCROSS.

A haul of the dredge was taken on this ground. Of the fifty-seven species recorded, twenty-six, all mollusca, were represented by dead shells only. *Corbula nucleus, Solen pellucidus, Syndosmya alba,* and *Nucula nitida* were each represented by two living specimens, these being the only living specimens of those species which we obtained. Shells of *Mactra stultorum* were common, although it was not found alive, nor in the stomachs of any fish captured in the bays. It was found, however, in spawning Plaice caught in the deep water off Portland. Of the other species recorded only few specimens were taken.

Soil, coarse sand and rocks.

List of Species.

PORIFERA.

Clione celata. One colony.

HYDROZOA.

Sertularella polyzonias.
Sertularia abietina.
Hydrallmania falcata.
Antennularia antennina.

ACTINOZOA.

Alcyonium digitatum. Several colonies on shale.
Adamsia palliata. Several.

ECHINODERMA.

Astropecten irregularis. One or two.
Asterias rubens. Two.
Ophiura ciliaris. Several.
Ophiothrix fragilis. One.
Echinus miliaris. One.

GEPHYREA.

Phascolion strombi (*Mont.*). One.

POLYCHÆTA.

Acholöe astericola. One.
Pectinaria sp.? Fragment of tube.
Lanice conchilega (*Pallas*).
Sabellaria spinulosa (*Leuck.*). Several on stones, shells, etc.
Serpula sp.?

CRUSTACEA.

Stenorhynchus phalangium. One.
Eupagurus Prideauxii. Several.
Anapagurus lævis. Three.
Porcellana longicornis. Several.

MOLLUSCA.

(Shells only, unless otherwise stated.)

Saxicava rugosa. A few.
Mya truncata. One.
Corbula nucleus. Two alive.
Solen ensis. A few.
,, siliqua. A few.
,, pellucidus. Two alive.
Syndosmya alba. Two alive.
Mactra stultorum. Common.
,, solida. A few.
Lutraria elliptica. A few.
Psammobia ferröensis. A few.
Tapes virginea. One.

MOLLUSCA—*continued.*

Venus striatula. A few.
Artemis exoleta. One.
Lucinopsis undata. A few.
Cardium aculeatum. One.
Cardium echinatum. A few.
Nucula nitida. Two alive.
Pecten pusio. A few.
„ opercularis. A few.
„ varius. A few.
Ostræa edule. A few.
Turritella communis. A few.
Natica monilifera. A few.
„ nitida. A few.
Murex erinaceus. One.
Aporrhais pes-pelecani. One.
Nassa reticulata. One alive.
„ incrassata. Several.
Buccinum undatum. One.
Fusus gracilis. One.

POLYZOA.

Bugula turbinata. One colony.
Cellaria sinuosa. One colony.

TUNICATA.

Ciona intestinalis. Two.
Ascidiella aspersa. Two.

TORBAY.

Station IV.

Although not a rich ground, as far as species are concerned, some of those which did occur were very common, notably *Asterias rubens*, *Ophiura ciliaris*, *Eupagurus Bernhardus* with the anemone *Sagartia parasitica*, *Portunus depurator*, and *Philine aperta*. *Syndosmya alba* was very common in the stomachs of Dabs.

Soil, fine sand to mud; depth, 4–5 fathoms.

List of Species.

ACTINOZOA.

Sagartia parasitica. Very common.
Actinoloba dianthus. Taken once.

ECHINODERMA.

Asterias rubens. Very common.
Ophiura ciliaris. Very common.

CRUSTACEA.

Maia squinado. Occasional.
Portunus puber. Occasional.
„ depurator. Very common.
Portunus holsatus. From stomach of Dab.
Eupagurus Bernhardus. Very common.

MOLLUSCA.

Solen siliqua. Shells.
„ pellucidus. In Plaice stomachs.
Syndosmya alba. In Plaice stomachs. Very common.
Mactra solida. In Plaice stomachs. Common.
Lutraria elliptica. Shells.

MOLLUSCA—*continued.*

Lucinopsis undata Shells.
Cardium aculeatum. Shells common ; one alive.
Mytilus edulis. Taken once.
Nucula nitida. In Plaice stomachs.
Natica monilifera. Not uncommon alive.
Nassa reticulata. Occasionally.
Buccinum undatum. Occasionally.
Philine aperta. Very common.
Sepia officinalis. Occasionally.

STATION IVA.

Portunus depurator and *Philine aperta* were the only species at all common. *Cardium aculeatum* was taken alive in moderate numbers, and one or two specimens of *Portunus arcuatus* and *Homarus vulgaris* were also taken.

Soil, sand and *Zostera* ; depth, 3–5 fathoms.

List of Species.

ECHINODERMA.

Asterias rubens. Not common.

CRUSTACEA.

Maia squinado. Occasional.
Portunus puber. Taken once.
„ depurator. Common.
„ arcuatus. Taken once.
Corystes cassivelaunus. Occasional.
Eupagurus Bernhardus. Rare.
Porcellana longicornis. Rare.
Palinurus vulgaris. Taken once.
Homarus vulgaris. Taken once.
Crangon vulgaris. Rare.

MOLLUSCA.

Cardium aculeatum. Not uncommon alive.
Mytilus edulis. Taken once.
Philine aperta. Very common.
Loligo Forbesii. Occasionally.
Sepia officinalis. Occasionally.

STATION V.

This ground was characterised chiefly by its foulness, caused by the presence of old baskets, boxes, rope, etc. *Sertularia abietina, Asterias rubens, Portunus depurator,* and *Philine aperta* were the commonest species.

Soil, mud ; depth, 6 fathoms.

List of Species.

HYDROZOA.

Hydractinia echinata. Not uncommon.
Sertularella polyzonias.
Diphasia pinnata.
Sertularia abietina. Common.
Sertularia operculata.
„ cupressina.
Hydrallmania falcata.

ACTINOZOA.

Alcyonium digitatum. Taken once.
Sagartia parasitica. Moderately common.
Actinoloba dianthus. Moderately common.

ECHINODERMA.

Astropecten irregularias. Moderately common.
Solaster papposus. Taken once.
Asterias rubens. Small, common.
Ophiura ciliaris. Occasional.
Echinocardium cordatum. Taken once.

POLYCHÆTA.

Aphrodite aculeata. Not uncommon.
Acholöe astericola. Taken once.

CRUSTACEA.

Maia squinado. Not uncommon.
Portunus depurator. Very common.
Eupagurus Bernhardus. Moderately common.
Porcellana longicornis. Not uncommon.
Homarus vulgaris. Taken once.

MOLLUSCA.

Solen vagina. In Plaice stomachs.
„ pellucidus. In Plaice stomachs.
Syndosmya alba. In Plaice stomachs.
Mactra solida. In Plaice stomachs.
Cardium aculeatum. Shells.
Pecten opercularis. Not uncommon.
Ostræa edule. Two.
Buccinum undatum. Not uncommon.
Philine aperta. Common.
Loligo media. (?) Not uncommon.
Sepia officinalis. Not uncommon.

Station VI.

This ground was remarkable for the large number of swimming crabs, *Portunus depurator*, which were taken on it. *Eupagurus Bernhardus*, *Porcellana longicornis,* and *Philine aperta* were also present in quantity, but not quite so common as *Portunus. Gonoplax angulatum* and *Turritella communis,* two mud-haunting species, were moderately common, whilst *Tritonia Hombergii*, a mollusc, which in the Plymouth neighbourhood is generally taken in 30 fathoms, is an interesting record. *Antedon bifida* was present on the rough ground at the Berry Head end of the station.

Soil, mud; depth, 8–10 fathoms.

List of Species.

HYDROZOA.

Sertularia abietina. Not uncommon.

ACTINOZOA.

Alcyonium digitatum. Not uncommon.
Sagartia parasitica. Common.
Adamsia palliata. Not uncommon.
Actinoloba dianthus. Not uncommon.

ECHINODERMA.

Antedon bifida. Taken once.
Astropecten irregularis. Moderately common.
Solaster papposus. Occasional.
Asterias rubens. Common.
Ophiothrix fragilis. Not uncommon.
Echinus miliaris. Not uncommon.

POLYCHÆTA.

Aphrodite aculeata. Not uncommon.
Acholoe astericola. Taken once.
Dasychone bombyx (*Dal.*). Occasional.
Serpula sp. ? Common.

CRUSTACEA.

Maia squinado. Occasional.
Cancer pagurus. Occasional.
Portunus depurator. Extremely common.
Gonoplax angulatum. Not uncommon.
Corystes cassivelaunus. Fairly common.
Eupagurus Bernhardus. Very common.
Eupagurus Prideauxii. Occasional.
Porcellana longicornis. Very common.

MOLLUSCA.

Saxicava arctica. Taken once.
Thracia pubescens. Shells.
Solen siliqua. Shells.
Syndosmya alba. In fish stomachs.
Lutraria elliptica. Shells.
Venus striatula. Shells.
Cardium aculeatum. Shells.
Pinna pectinata. Shells.
Pecten opercularis. Occasional.
„ maximus. Shells.
Pecten varius. Taken once.
Ostræa edule. Occasionally.
Trochus zizyphinus. Common.
Turritella communis. Not uncommon.
Buccinum undatum. Not uncommon.
Philine aperta. Very common.
Tritonia Hombergii. Three.
Loligo Forbesii. Taken once.
„ media (?). Taken once.

POLYZOA.

Cellaria fistulosa.
Lepralia foliacea.

TUNICATA.

Phallusia mammillata. One.
Ciona intestinalis. One.

TEIGNMOUTH BAY.

STATION VII.

Philine aperta, *Portunus depurator*, and *Aphrodite aculeata* were the only common species. *Pinnotheres pisum* was present in nearly all the specimens of *Mytilus edule* taken, but *Mytilus* itself was not common. *Polybius Henslowii* was taken occasionally.

Soil, coarse sand; depth, 5–6 fathoms.

List of Species.

ACTINOZOA.

Sagartia parasitica. Not uncommon.
Actinoloba dianthus. Not uncommon.

ECHINODERMA.

Astropecten irregularis. Taken once.
Asterias rubens. Not common.
Ophiura ciliaris. Not common.

HIRUDINEA.

Pontobdella muricata. Occasional.

GEPHYREA.

Phascolion strombi. Taken once.

POLYCHÆTA.

Aphrodite aculeata. Fairly common.
Lanice conchilega. In Sole stomachs.

CRUSTACEA.

Maia squinado. Occasionally.
Carcinus mænas. Taken once.
Portunus depurator. Common.
Polybius Henslowii. Occasionally.
Pinnotheres pisum. Common in *Mytilus*.
Eupagurus Bernhardus. Not uncommon.
Nika edulis. In stomach of *Scyllium*.

MOLLUSCA.

Solen ensis. Shells.
„ siliqua. Shells.
„ vagina. Shells.
„ pellucidus. In Sole stomachs.
Syndosmya alba. In Sole stomachs.
Mactra solida. Common in Plaice stomachs.
Lucinopsis undata. Shells.
Cardium aculeatum. Shells.
„ echinatum. Shells.
Mytilus edulis. Not uncommon.
Nucula nitida. In Sole stomachs.
Pecten opercularis. Occasional.
„ maximus. Once only.
Ostræa edule. Not common.
Buccinum undatum. Occasional.
Philine aperta. Common.
Loligo Forbesii. Occasional.
„ media. (?) Not uncommon.
Sepia officinalis. Not uncommon.

STATION VIII.

Serpula sp.?, *Portunus depurator*, and *Pecten opercularis* were the commonest species on this ground. *Pinnotheres pisum*, as in Station VII., was present in nearly all the mussels taken.

Soil, coarse sand; depth, 4–6 fathoms.

List of Species.

Sagartia parasitica. Fairly common.
Adamsia palliata. Not common.
Actinoloba dianthus. Moderately common.

ECHINODERMA.

Asterias rubens. Moderately common.
Echinus miliaris. Rare.

HIRUDINEA.

Pontobdella muricata. Occasional.

POLYCHÆTA.

Serpula sp. ? Common.
Nereis fucata (*Sav.*). In shell with Hermit-crab.

CRUSTACEA.

Maia squinado. Not uncommon.
Carcinus mænas. Few ; small.
Portunus depurator. Common.
Pinnotheres pisum. Occasionally.
Eupagurus Bernhardus. Fairly common.
„ Prideauxii. Taken once.
Homarus vulgaris. Taken once.
Galathea strigosa. Taken once.

MOLLUSCA.

Mytilus edulis. Occasionally.
Pecten opercularis. Common ; small.
Ostræa edule. Not uncommon.
Buccinum undatum. Occasionally.
Cypræa Europæa. Not uncommon.
Philine aperta. Not uncommon.
Aplysia punctata. Not uncommon.
Loligo Forbesii. Occasional.
„ media (?). Occasional.
Sepia officinalis. Moderately common.

TUNICATA.

Phallusia mammillata. Occasional.
Ciona intestinalis. Occasional.

STATION IX.

This was the richest ground investigated, the commonest species being *Actinoloba dianthus*, *Echinus miliaris*, *Serpula sp.*, *Gammarus locusta*, and *Ostræa edule*, the last species being sufficiently common to make oyster-dredging a profitable occupation. Both *Serpula* and *Actinoloba* were generally attached to shells, notably the inside of a *Cyprina* valve, and to stones. Among the less common species which were not taken alive elsewhere were *Synapta digitata*, *Ophiactis Balli*, *Henricia sanguinolenta*, *Galathea squamifera*, *Protula tubularia*, *Kellia suborbicularis*, *Cardium echinatum*, and *Aporrhais pes-pelecani*.

Soil, fine sand, mud, and stones ; depth, 11–12 fathoms.

List of Species.

PORIFERA.

Suberites domuncula. Occasional.

HYDROZOA.

Sertularella polyzonias.
Sertularia abietina.
Hydrallmania falcata.

ACTINOZOA.

Alcyonium digitatum. Occasional.
Sagartia parasitica. Common.
Adamsia palliata. Not uncommon.
Actinoloba dianthus. Very common.

ECHINODERMA.

Synapta digitata. Fragment.
Astropecten irregularis. Not uncommon.
Solaster papposus. Taken once.
Asterias glacialis. Taken once.
,, rubens. Common.
Henricia sanguinolenta. Occasional.
Ophiura ciliaris. Not uncommon.
Ophiothrix fragilis. Occasional.
Ophiactis Balli. Occasional.
Echinus miliaris. Very common.
,, esculentus. Occasional.

GEPHYREA.

Phascolion strombi. Common.

HIRUDINEA.

Pontobdella muricata. Occasional.

POLYCHÆTA.

Aphrodite aculeata. Very common.
Chætopterus variopedatus. Not uncommon.
Polymnia nebulosa (*Mont.*). Taken once.
Protula tubularia (*Mont.*). Not uncommon.
Serpula sp.? Very common.

CRUSTACEA.

Stenorhynchus longirostris. Occasional.
Inachus dorsettensis. Occasional.
,, dorynchus. Occasional.
Maia squinado. Common.
Portunus puber. Common.
,, depurator. Common.
Gonoplax angulatum. Occasional.
Pinnotheres pisum.
Eupagurus Bernhardus. Common.
,, Prideauxii. Not uncommon.
,, cuanensis. Occasional.
Porcellana longicornis.
Galathea squamifera.
,, dispersa.
Gammarus locusta. Abundant.

MOLLUSCA.

Solen ensis. Shells.
,, siliqua. Shells.
,, vagina. Shells.
Mactra solida. Shells.
Venus striatula. Shells.
Lucinopsis undatum. Shells
Cyprina islandica. One alive and shells.
Cardium aculeatum. Shells.
,, echinatum. Not uncommon.
Kellia suborbicularis. Two.
Mytilus edulis. Not uncommon.
Pinna pectinata. Shell.
Pecten maximus. Not uncommon.
,, opercularis. Moderately common.
Ostræa edule. Common.
Trochus zizyphinus. Common.
,, magus. Shell.
Turritella communis. Common.
Aporrhais pes-pelecani. Taken once.
Natica monilifera. Shells, common.
Purpura lapillus. Taken once.
Buccinum undatum. Not uncommon.
Loligo Forbesii. Occasional.
,, media (?). Occasional.

POLYZOA.

Cellaria fistulosa. Occasional.
,, sinuosa. Occasional.
Lepralia foliacea. Not uncommon.

TUNICATA.

Phallusia mammillata. Occasional.
Ciona intestinalis. Occasional.
Ascidiella aspersa. Occasional.

THE "CORNER."

This ground was characterised by the large quantity of hydroids which were present, notably *Obelia longissima*, *Campanularia verticillata*, *Halecium halecinum*, *Sertularella polyzonias*, *Sertularia abietina*, *Hydrallmania falcata*, and *Antennularia antennina*. *Atelecyclus heterodon* was also present in moderate numbers. Several of the smaller crustacea were taken, *Hyas coarctatus*, *Galathea dispersa*, *Crangon vulgaris*, and *C. spinosus*, due possibly to the hydroids filling up the meshes of the trawl.

Turritella communis, which was common, especially in the muddy part of the ground, generally had hydroids attached to the shell. A large species of *Botryllus*, the "pork" of the Plymouth trawlers, was not uncommon.

Soil, mud, fine sand, and coarse sand; depth, 30 fathoms.

List of Species.

PORIFERA.

Suberites domuncula. Occasional.

HYDROZOA.

Hydractinia echinata. Occasional.
Obelia longissima. Common.
Campanularia verticillata. Common.
Lafӧea dumosa. Occasional.
Halecium halecinum. Common.
Sertularella Gayi. Not uncommon.
„ polyzonias. Common.
Sertularia abietina. Common.
Hydrallmania falcata. Very common.
Antennularia antennina. Common.
„ ramosum. Not uncommon.
Aglaophenia myriophyllum. Not uncommon.

ACTINOZOA.

Alcyonium digitatum. Occasional.
Sagartia parasitica. Common.
Adamsia palliata. Not uncommon.

ECHINODERMA.

Astropecten irregularis. Not uncommon.
Asterias rubens. Common; small.
„ glacialis. Two taken.
Ophiothrix fragilis. Not uncommon.
Echinus miliaris. Not uncommon.
Spatangus purpureus. Fragment only.

GEPHYREA.

Phascolion strombi. One.

POLYCHÆTA.

Aphrodite aculeata. Not common.
Gattyana cirrosa (*Pall.*). One.
Acholöe astericola. Two.
Chætopterus variopedatus. Occasional.
Sabellaria spinulosa. Occasional.
Sabella pavonina. Occasional.

CRUSTACEA.

Stenorhynchus longirostris. Common.
Inachus dorsettensis. Not uncommon.
Hyas coarctatus. One.
Maia squinado. Occasional.
Cancer pagurus. Occasional.
Portunus depurator. Very common.
Atelecyclus heterodon. Common.
Corystes cassivelaunus. Not uncommon.
Eupagurus Bernhardus. Common.
„ Prideauxii. Not uncommon.
„ cuanensis. Occasional.
Porcellana longicornis. Common.
Galathea dispersa. Common.
Crangon vulgaris. Occasional.
„ spinosus. Two.
Scalpellum vulgare. Few.

MOLLUSCA.

Syndosmya alba. Shells.
Mactra solida. Shells.
Venus striatula. Shells.
Lucinopsis undata. Shells.
Cyprina islandica. Shells.
Cardium echinatum. Shells.
Pinna pectinata. Shells.
Pecten opercularis. Few alive.
Ostræa edule. Shells.
Dentalium entale. Shells.
Trochus zizyphinus. Shells.
„ granulatus. Shells.
Turritella communis. Common alive.
Natica monilifera. Shells.
Buccinum undatum. Few alive.
Philine aperta. Few alive.
Loligo Forbesii. Occasional.
„ media (?). Occasional.
Sepia officinalis. Occasional.
„ elegans. Occasional.

TUNICATA.

Botryllus sp.? Few colonies.

SUMMARY.

HYDROZOA.

Hydroids were commonest in the "Corner," *Campanularia verticillata*, *Sertularella polyzonias*, *Halecium halecinum*, and *Hydrallmania falcata* being the most frequent. Station I. also gave about the same number of species, but not in any quantity, *Sertularia abietina* being the only common form.

ACTINOZOA.

Sagartia parasitica was common on Stations I., IV., VI., IX., and the Corner; absent from Limpet Rocks and Station IVa. *Adamsia palliata* was commonest at Station I. and the Corner. *Actinoloba dianthus*, very common on Station IX., not uncommon Stations V., VI., VII., VIII., but absent from Start Bay and Stations IV. and IVa. in Torbay. *Peachia triphylla* and *Sagartia viduata* were recorded once from Stations II. and III. respectively.

ECHINODERMA.

Excepting for the presence of *Echinocyamus pusillus* in the stomachs of Plaice, the Skerries Bank was quite devoid of Echinoderms. *Astropecten irregularis*, *Asterias rubens*, *Ophiura ciliaris* were more or less common in all the bays, chiefly on fine sand and mud. *Asterias glacialis*, of which the previous most easterly record was Salcombe, was taken in Teignmouth Bay (Station IX.); the Corner; one and a half miles off Berry Head; and in Brixham Harbour, but only one or two specimens from each locality. *Echinus miliaris* was common only on Station IX., whilst the following were found there and not elsewhere: *Synapta digitata*, *Henricia sanguinolenta*, *Ophiactis Balli*, and *Echinus esculentus.*

POLYCHÆTA.

Aphrodite aculeata was present in all the bays, but common at Station IX. only. *Acholöe astericola*, although not always recorded, was probably present on all stations on which *Astropecten irregularis* was commonly taken. *Chætopterus variopedatus* was characteristic of Stations I. and IX. and the Corner; whilst *Serpula* sp. ? was abundant on Station IX. and common on Stations VI. and VIII. *Polymnia nebulosa* and *Protula tubularia* were taken on Station IX. only. *Nereis fucata* is recorded only from Station VIII., but it was probably present on nearly all the grounds with *Eupagurus Bernhardus.*

CRUSTACEA.

Maia squinado was common only on Stations I., III., and IX. *Cancer pagurus* was common on the Skerries (Station III.), but only a few specimens were taken on the other grounds. *Carcinus mænas* was only taken in Teignmouth Bay, whilst *Portunus depurator* was common on all grounds excepting the Limpet Rocks, especially so on Stations VI., IV., V., and the Corner. *Pinnotheres pisum* (the "poison crab") was present only in Teignmouth Bay, but there nearly every mussel examined had one or more—one had three, all males. *Gonoplax angulatum* was taken alive on Stations VI. and IX. only; whilst *Atelecyclus heterodon* was common on Station I. and the Corner and absent from the rest. *Corystes cassivelaunus* was common only on Stations I. and VI. *Eupagurus Bernhardus* was more or less common on all the grounds, being especially so on Stations I., IV., and VI. *E. Prideauxii* was common only on Station I. and the Corner. *Porcellana longicornis*, common only on Station VI.

MOLLUSCA.

Chiefly represented by shells. Living specimens of the following were taken:—*Solen pellucidus*, *Nucula nitida*, *Corbula gibba*, *Syndosmya alba* on the Limpet Rocks; *Cardium aculeatum*, Station IVA.; *C. echinatum*, Station IX.; *Mytilus edulis* from Stations IV., VII., VIII., and IX. *Pecten opercularis* and *Ostræa edule* were commonest in Teignmouth Bay. *Turritella communis*, common only on Stations VI., IX., and the Corner, generally with hydroids (the Corner) or *Alcyoni-*

dium sp. ? (Stations VI. and IX.) growing on the shell. *Natica monilifera* was taken alive on Stations I. and IV. only, but shells were common on most grounds. *Buccinum undatum* was common only on Station VI.; *Philine aperta*, common in Torbay and Station VII. of Teignmouth Bay. The following were taken alive on one station only, and generally in very small numbers:—*Aplysia punctata* (Station VIII. not uncommon), *Tritonia Hombergii* (Station VI.), *Dendronotus arborescens* (Station III.), *Æolis papillosa* (Station III.).

Of the Cephalopoda, *Loligo Forbesii* occurred in Torbay, Teignmouth Bay, and the Corner; *L. media* (?) in all the bays and the Corner; *Sepia officinalis* in all the bays; whilst *S. elegans* is recorded from Station I. and the Corner.

As summary to the foregoing pages, a few remarks may be made on the comparative abundance of some of the common forms on the various grounds in the bays, as shown in the following table:—

List of Identified Species regarded as distinctive of the Grounds named.

× = present. c = common. cc = very common.

SPECIES.	START BAY.			TORBAY.				TEIGNMOUTH BAY.		
	I.	II.	III.	IV.	IVA.	V.	VI.	VII.	VIII.	IX.
Actinoloba dianthus .	—	—	—	—	—	×	×	×	×	cc
Echinus miliaris . .	—	—	—	—	—	—	c	—	—	cc
Aphrodite aculeata . .	×	×	—	—	—	×	×	c	—	cc
Chætopterus variopedatus	×	—	—	—	—	—	—	—	—	×
Protula tubularia . .	—	—	—	—	—	—	—	—	—	c
Serpulids . . .	—	—	—	—	—	—	c	—	×	cc
Maia squinado . .	cc	×	c	×	×	×	×	×	×	cc
Portunus puber . .	—	—	—	—	—	—	—	—	—	c
„ depurator .	c	c	×	cc	c	cc	cc	c	c	c
Corystes cassivelaunus .	c	—	—	—	×	—	×	—	—	—
Atelecyclus heterodon .	×	—	—	—	—	—	—	—	—	—
Pinnotheres pisum . .	—	—	—	—	—	—	—	×	×	×
Gonoplax angulata . .	×	—	—	—	—	—	c	—	—	×
Eupagurus Bernhardus .	cc	×	×	cc	×	c	cc	×	c	c
„ Prideauxii .	cc	×	×	—	—	—	×	—	×	c
Mactra solida . . .	×	—	—	c	—	c	—	c	—	×
Syndosmya alba . .	—	×	—	cc	—	c	c	c	—	—
Solen pellucidus . .	—	c	—	×	—	×	—	×	—	—
Mytilus edulis . .	—	—	—	—	×	—	—	×	×	×
Ostræa edule . . .	—	—	—	—	—	×	×	×	×	cc
Trochus zizyphinus .	—	—	—	—	—	—	c	—	—	c
Turritella communis .	—	—	—	—	—	—	×	—	—	c

It is of interest to note that there is a considerable difference in the size of some of the species in the different bays. *Mactra solida*, for example, in Torbay and Teignmouth Bay is represented by small specimens only; whilst in Start Bay those obtained were much larger. It is possible that such a distribution of the invertebrate fauna has a considerable, if not a predominant, influence on the distribution of the small and large fish. In Torbay and Teignmouth Bay, for example, the Plaice are, on the whole, much smaller than in Start Bay.

II. Food of Fishes.

The contents of the stomachs of various fish were examined, with the following result:—

PLAICE.

(*Pleuronectes platessa.*)

START BAY.—Nine fish examined, 7 to 20 inches in length.

ECHINODERMA.

Ophiura ciliaris. In one.

Echinocyamus pusillus. In two, one of which was full.

POLYCHÆTA.

Nephthys sp.? In two.

Sabella pavonina. In one.

CRUSTACEA.

Eupagurus sp.? In one.

MOLLUSCA.

Corbula gibba. In one.

Solen pellucidus. In two.

„ *ensis.* In two.

Syndosmya alba. In three, all of which were full.

TORBAY.—Sixty-three fish, of which twenty-four were 12 inches and more in length.

ECHINODERMA.

Ophiura ciliaris. Arms only in five.

POLYCHÆTA.

Nephthys sp.? In eight.

Unidentified. In twenty.

CRUSTACEA.

Corystes cassivelaunus. In three.

Crab fragments. In one.

Amphipod. In one.

MOLLUSCA.

Solen ensis. In one.

„ *vagina.* Siphons only in five.

„ *pellucidus.* In two.

Syndosmya alba. In eleven.

Mactra solida. In thirty. In fifteen of the plaice under 12 inches this mollusc constituted the sole food.

Nucula nitida. In one.

Philine aperta. The sole food in three or four of the larger Plaice.

Lamellibranch fragments. In three.

TEIGNMOUTH BAY.—Twelve fish examined, eight being over 12 inches in length.

POLYCHÆTA.

Remains in one.

MOLLUSCA.

Solen siliqua. Fragments in one.

Mactra solida. In nine, constituting the sole food.

Syndosmya alba. In one.

In the eighty-four fish examined, the following occurred in 10 % and over of the stomachs:—*Mactra solida* (46 %), Polychæte remains unidentified (25 %), *Syndosmya alba* (17 %), *Nephthys* sp.? (12 %).

DABS.

(*Pleuronectes limanda.*)

START BAY.—Ten fish were examined, of which five were over 8 inches in length.

POLYCHÆTA.

Fragments in one.

ECHINODERMA.

Ophiura ciliaris. In four.

CRUSTACEA.

Eupagurus sp.? In three.
Portunus sp.? In four.
Crab fragments. In one.

MOLLUSCA.

Syndosmya alba. In one.
Mactra solida. In one.
Pecten opercularis. In two.
Lamellibranch fragments. In one.
Philine aperta. In one.
Loligo media (?). In one.

PISCES.

Ammodytes sp.? In one.

TORBAY.—Seventeen fish examined, ten of which were under 8 inches in length.

ECHINODERMA.

Ophiura ciliaris. In two.
Echinus sp.? Fragments in one.

POLYCHÆTA.

Nephthys sp.? In one.
Sabella pavonina. In one.
Fragments in two.

CRUSTACEA.

Eupagurus sp.? In one.
Portunus holsatus. In one.
Portunus sp.? In one.
Amphipod. In one.

MOLLUSCA.

Solen sp.? In two.
Syndosmya alba. In one.
Cardium sp.? In one.
Philine aperta. In one.

"HITCHES" OFF TORBAY.—Eight fish examined 7½ to 10 inches in length.

CŒLENTERATA.

Sagartia? sp.? Six of the dabs examined had been feeding on a small anemone, somewhat resembling *Sagartia viduata*, but they were too much digested to identify with any certainty. As many as fifty were counted in one stomach.

POLYCHÆTA.

Nephthys sp.? In one.
Fragments. In one.

CRUSTACEA.

Eupagurus sp.? In two.
Portunus sp.? In two.

MOLLUSCA.

Philine aperta. In one.
Turritella communis. Shell in one.
Æolis sp.? In one.

In the thirty-five fish examined, the following were present in 10 % or more of the stomachs:—*Portunus* sp. var. (22 %), *Sagartia?* sp.? (16 %), *Ophiura ciliaris* (16 %), *Eupagurus* sp.? (16 %), Polychæte remains (11 %).

SOLES.

START BAY.—Fifteen fish examined.

POLYCHÆTA.

Remains in four.

MOLLUSCA.

Solen ensis. In six.
,, *pellucidus.* In three.
Turritella communis. In one.

TEIGNMOUTH BAY.—Four fish.

POLYCHÆTA.

Nereis sp. ? In one.
Lanice conchilega. In one.

MOLLUSCA.

Solen pellucidus. In three.
Syndosmya alba. In all.
Nucula nitida. In two.

BRILL.

START BAY.—Forty-nine fish examined.

PISCES.

Clupea sprattus. In one.
Gadus merlangus ? In one.
Ammodytes tobianus. In thirty or more.
,, *lanceolatus.* In thirty or more.

TORBAY.—One brill of 8 inches was examined, and found to contain a single *Gobius minutus.*

TEIGNMOUTH BAY.—Three fish were examined, of which one was empty and the others contained respectively a sand-eel (*Ammodytes*) and fish remains.

TURBOT.

(*Rhombus maximus.*)

START BAY.—Three fish were examined, and contained respectively: Sandeels, Grey Gurnard, and *Portunus holsatus.*

DRAGONET.

(*Callionymus lyra.*)

START BAY.—Fourteen fish were examined.

ECHINODERMA.

Ophiura ciliaris. In two.

CRUSTACEA.

Eupagurus sp. ? In one.

MOLLUSCA.

Solen sp. ? Fragments in two.
Mactra solida. In six.
Tapes sp. ? In one.
Nucula nitida. Many in one.
Philine aperta. In one.
Lamellibranch fragments. In two.

GREATER WEEVER.

(*Trachinus draco.*)

START BAY.—Several fish examined.

CRUSTACEA.

Pandalus sp. ? In three.

PISCES.

Ammodytes sp. ? In one.
Gadus sp. ? probably *pollachius.* In the remainder.

PIKED DOG-FISH.

(*Acanthias vulgaris.*)

START BAY.—Seven fish examined.

POLYCHÆTA.

Polynoid remains. In one.

CRUSTACEA.

Eupagurus sp. ? In one.
Portunus holsatus. In two.

PISCES.

Ammodytes tobianus. In two.
Clupea sprattus. In two.
Gobius sp. ? In one.

ROUGH DOG.

(*Scyllium canicula.*)

TEIGNMOUTH BAY. Two fish.

GEPHYREA.

Phascolion strombi. In one.

POLYCHÆTA.

Remains. In one.

CRUSTACEA.

Nika edulis. In one.
Eupagurus sp. ? In one.

MOLLUSCA.

Buccinum undatum. Operculum only.
Loligo media. (?) Several in one.

ANGEL.

(*Rhina squatina.*)

TEIGNMOUTH BAY.—Two fish examined, each of which contained one *Portunus depurator* and many *Loligo media.* (?)

THORNBACK.

(*Raia maculata.*)

START BAY.—The only fish examined contained one each of the following Crustacea:—

Eupagurus sp. ?
Stenorhynchus sp. ?
Corystes cassivelaunus.
Portunus depurator.
Gonoplax angulatum.

BLONDE.

(*Raia blanda.*)

START BAY.—Eight fish examined.

CRUSTACEA.

Gastrosaccus spinifer. Common in six.

PISCES.

Ammodytes sp.? Common in six. | *Pagellus* sp. In two.

Trachinus vipera. In two.

DORY.

(*Zeus faber.*)

START BAY.—All those examined contained numbers of small Gadoids, probably *Gadus pollachius.*

Although the number of fish stomachs examined is too small to draw any definite conclusion, the results tend to confirm the observations of Petersen,* Herdman,† and the Scottish Fishery Board,‡ which show that the dab may not be a serious competitor with the plaice in the matter of food. Both species appear to feed at times on the same organisms; but the plaice, on the grounds examined, confined themselves chiefly to Mollusca and Polychæta, whereas the dab did not specialise in any one group. The dab, therefore, could only become a serious competitor with the plaice if it largely predominated in numbers. The presence of *Sagartia?* in such numbers in the stomachs of dabs from the "Hitches" is an interesting record. It is probable that the anemone was attached to *Turritella* or other gastropod shells, as one or two were found in that position.

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* Petersen, "Biology of our Flatfishes," 1893, p. 30.

† Herdman and Scott, *Trans. Liverpool Biological Society*, vol. ix., 1895, pp. 107–30.

‡ *Report S. F.B.*, x. pp. 211–31 ; xx. pp. 486–538.

Fishing Nets, with Special Reference to the Otter-trawl.

By

H. M. Kyle, M.A., D.Sc.

(With Plates I. and II.)

THE increased attention which has been paid within recent years to fishery statistics has revealed, amongst other troublesome things, that the instruments employed play an important part both as to quantity and quality in the result. It is not necessary to discuss whether any of the instruments as now used give a fair sample of the contents of the water or ground, but it certainly is the case that different apparatus will give different samples. Let a beam-trawl and an otter-trawl work for a year over the same ground alongside drift-nets and fixed trammel-nets or gill-nets, and we can guarantee that the results will differ from one another. In the case of the drift-nets we should have a few forms probably in large quantity, in the others a great variety of forms, but in different proportions in each. And again, those obtained by the drift-nets would be practically absent from the trawls. It thus behoves the naturalist to make every kind of fishing apparatus subservient to his use, if he desires to obtain even an approximate measure of fish-life in the sea.

Up to the present time the fishing gear employed by naturalists has been that of the practical fishermen, and rightly too. For a naturalist to devise a new and better type of fishing apparatus than exists, he must serve an apprenticeship in the making and working of the old, so that he may share with the practical men the experience of many generations. The danger then arises, however, of his becoming too much enamoured of the one or two special types he himself has had experience of and losing sight of the others. It would be impossible to find a more careful or better description of a trawl and the working of that trawl than the one given by Dr. Petersen for what he calls the "otter drag-seine"; yet an essential portion of the trawl was omitted, and the realisation of his ideas consequently has fallen far short of the ordinary *beam-* or *otter-trawl.*

The latter, it must be remembered, are the consummation of the experience not of one or two types of fishing apparatus, but of all. They are the successful and highly developed forms of a long series, so that every little part and detail has come at some time under the searching eye of experience. To realise their full worth, one must hark back to the more primitive forms and retrace their development. It is interesting to note that this is just what Dr. Petersen has done. His so-called "otter drag-seine" and its subsequent alterations repeat, to a certain extent, the history of the real *otter-trawl,* and in his latest work he has attained to the appreciation of the latter in all its parts.

I have not the slightest doubt that Dr. Petersen, with his admirable command of the English language, would be able to give a good account of the English otter-trawl now that he has one in his possession, but his distance from England, where the right names and the relative importance of the various parts might be explained to him, constitute a great difficulty. It seems more appropriate, therefore, that a detailed description should come from the English side.

As stated above, the *otter-trawl* is the last of a long series of successful and unsuccessful experiments with fishing gear. I think it advisable, therefore, to preface its description with a brief reference to past history and to the various forms of apparatus used in this and in other countries. Not knowing these, one would be unable to appreciate the finer details of the *otter-trawl* and the advance it has made from the more primitive types.

The numerous forms of fishing apparatus may be classified according to the mode of working them—*fixed nets,* if they are moored to the beach, or at the bottom of the sea; *movable nets,* if they are dragged through the water.

The simplest form of the fixed nets is a dam of stones or rushes between tide-marks leading down into a simple "pound" also made of rushes. More advanced forms are seen in the eel-traps of Holland,* the "fyke-nets" and "weirs" of America,† and the salmon stake-nets of Scotland. In all, the principle is the same. A "leader" of network, in some cases two, is placed across the direction in which the fish are supposed to travel, and guides them into a cunningly constructed labyrinth, from which they cannot escape. In rocky parts the leader is removed, and the "pound" simply moored off the rocks in deep water. It may seem strange that the openings, which are of good size, cannot be used by the fish for exit as well as entry, but the difficulties of a wasp which has entered a room through a slightly open window are very small in comparison with those of a fish when it is once in the "heart" of the pound.

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* The inshore fishing apparatus of the Netherlands. *Mededeel over Visscherij,* 1899.

† "Fyke-nets," *Bull. U.S. Fish Commission,* xii., 1892.

These nets are only useful for the capture of inshore fish or fish which enter rivers, but there are two forms of *fixed* nets, probably derived from the "leader" of the pound-net, which are of great importance in sea fishing. These are the *gill-net* and the *trammel.* In the former, as the name denotes, the fish are caught by the gills; in the latter they are entrapped in a bag or pocket of their own making.

Though *gill-nets* are extensively used in this country, it is mostly in the form of *drift-nets* for fish swimming near the surface, such as mackerel or herring. The net is made fast—at one end only—to the boat, and boat and net drift together. Sometimes the head-line is sunk below the surface by extra leads on the foot-rope when the fish are swimming deep, and they frequently catch fish—for example, whiting—which keep near the bottom as a rule. In one or two places these nets are moored in fishing for herring, and quite within the last few years the old method of sinking the net to the bottom has been revived on the east coast of Scotland.*

In the United States,† however, *gill-nets* are, as a rule, *fixed nets*, and only occasionally *drift-nets.* The enormous part they play in the American fisheries may be judged from this, that each boat is said to have an outfit of gill-nets which would extend twenty to thirty miles, if set at one time.

The *trammel*‡ is a compound net usually in three layers, of which the two outer are of wide mesh stretched out taut, whilst the middle layer is of very small mesh with plenty of slack. Consequently, if a fish strike the net on either side it will pass through the first layer and drive the second through the third, and thus becomes entrapped in a pocket of its own making. These nets are employed on the south-west coast of England and round the Channel Islands for the capture of red mullet, though they catch all kinds of fish—soles, plaice, dories, and even crabs and lobsters. Like the gill-net, the trammel is moored upright to the bottom by means of lead on the foot-rope and corks on the head-rope, and like it also is very useful on rough or rocky ground. The advantage which the *trammel* has over the *gill-net* consists in its ability to catch different sizes and, therefore, a greater variety of fish.*

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* The result of this is said to have been a greatly increased catch, amongst other fish, of haddock, on grounds which were supposed to have been cleaned out by the trawlers. *Gill-nets* were formerly used also for the capture of crabs and lobsters on the south coast of England.

† Augur, *Bull. U.S. Fish Commission*, xiii., 1893, p. 381.

‡ Wilcocks, *The Sea Fisherman*, London, 1875, p. 244; Holdsworth, *Deep Sea Fishing and Fishing Boats*, London, 1874, p. 175.

The utility of these two forms of nets as complementary to trawls can hardly be overestimated. They reach ground the trawl cannot touch, and might be used in any part of the North Sea. Incidentally, it may be mentioned that the United States Fish Commission steamer *Albatross* had twelve different kinds of *gill-nets* and two *trammels* as part of its fishing apparatus.†

There are various other forms of *fixed nets*, such as the *stow-net* ‡ ("Ankerkuilen" of Holland) for sprats and whitebaits, which are used in tidal waters or streams. They are not likely to be of any service in deep-sea fishing, so that further mention of them is unnecessary.

The peculiarity of the preceding nets is that they are, for the most part, stationary, so that the responsibility for being caught rests with the fish themselves. The traps laid are exceedingly subtle, and are the result of generations of experience of the habits, habitat, and even the structure of the fish ; but when the traps are once laid man retires, and the fish do the rest. In the case of *movable* nets man does not wait for the fish to come to him, and, not content with devising ingenious instruments for their capture, pursues them with all his might and drags them in by main force. The two methods of fishing are therefore strongly antagonistic, and cannot both be pursued on the same ground at one and the same time.

It is by means of *movable nets* that naturalists—in Europe at any rate—have done their work in the past, and the tendency at the present time is to continue doing so. This is founded on the notion that *movable nets* may be made to give a quantitative measure of the fish in the sea.

The principle of the *movable net* is simply that of collecting together all the fish within a certain compass and dragging them to land or into a boat. Both these methods seem to have been pursued in the earliest times of which we have definite records by Phœnicians and Greeks. It is from the latter, indeed, that we derive our modern word *seine* or *sean*, and it is suggested that the Phœnicians, in the course of their wanderings, taught the use of this net to the men of Cornwall.* However this may have been, it is interesting to note that in passing from the shores of the Mediterranean to the coasts of Great Britain we can mark out every stage in the evolution of the beam- and otter-trawls from the primitive ground- or long haul-seine. The word *seine* is thus generic, and on historical grounds Dr. Petersen is quite entitled to call his *otter-trawl* a *seine,* but so many forms of nets are already included under this term that it is advisable to limit its applicability. In England *seine* is applied only to those nets which are hauled in on the shore, and so strict is the usage that one and the same net may have different names. When hauled in on the shore it is a *seine ;* when hauled in on a boat it is a *tuck-net.* Rightly speaking, *trawls* are therefore *tuck-nets,* but as these latter are only used from small boats in shallow water, and the term has arisen from the peculiar method of hauling in the net, the word *trawl* is more strictly applied to the apparatus for deep-sea fishing. Though the fields denoted by these three terms overlap to a slight extent, they are quite distinct, and it prevents confusion to limit the use of the terms correspondingly.

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* The *gill-net* is made like an ordinary drift-net. The *trammel* is usually from 30 to 50 fathoms (60 to 100 m.) long and 1 to 2 fathoms deep. The middle layer is just double this when stretched out. The meshes of the outer layers are from 4 to 5 inches from knot to knot, and those of the middle layer about 1 inch. The foot-rope is weighted according to depth and strength of tide. The price varies according to material used and length. A *trammel* of 50 fathoms made of *cotton* and finished completely costs £12. If the inner wall only is of cotton and the two outer of hemp, about £8. These may be obtained from the well-known Bridport makers (South Dorset), Messrs. Hounsell or Messrs. Gundry.

† Tanner, *Bull. U.S. Fish Commission*, xvi., 1896.

‡ See Wilcocks, *loc. cit.;* Holdsworth, *loc. cit.;* Hoek, *Verslag Staat Ned. Zeevisch*, 1896.

In its simplest form the *seine* is simply a weighted ground-rope and buoyed head-rope, between which hangs the net. The mode of working is likewise simple. A boat pays out the net some little distance to sea, the ropes attached to each end are brought ashore at a suitable spot, and the whole net is then gradually drawn to the beach.

The changes rung on this simple form are almost too numerous to mention. The length and depth vary, the mesh may be large or small, the size of mesh is different in different parts, the "wings" may be of great length, it may have a "bunt" or "bag" in the centre, and so on. Each kind of net has its distinct uses, and each has its distinct name, as a rule, according to the fish sought after. Usually each net has two sizes of mesh, often three or even four, those in the centre or bunt being smaller than those in the wings, in order to entrap but not mesh the fish. In this form the *ground-* or *long haul-seine* is in use in almost all countries of Europe,† but in none is it employed to such an extent as in the United States. All the aids that modern invention can give, a steamer for shooting the net, and steam winches for hauling it in, are there employed.

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* See Couch, *Fishes of the British Islands*, vol. ii. pp. 91–6. σαγηνη was transformed through the Latin Vulgate *sagena* into the Anglo-Saxon *segne*, and this has become the English and French *seine* or *sean*, the Dutch *zegen.*

† It is the *Tratta* or *Sciabica* of Italy, the *Bourgin* or *Seine* of France, the *Zegen* of Holland. The sight of the swarthy, half-naked fishermen hauling in their long seine on the beach at Posilipo, near Naples, is one of the things which cling to one's memory of that famous city.

On the south coast of England probably the best-known forms of this kind of net are the *sweep-nets* for mackerel and pilchard. These are used to surround a shoal of these fish; and a second smaller net—the *stop-net*—is employed to close the opening in the circle which the large seine is making round the shoal. When the circle is completed the *stop-net* is removed, and the whole concern is dragged towards the shore if possible. If the fish are exceedingly numerous, another net—the *tuck-net*—is shot inside the seine, and the fish are removed in batches.*

In the United States † the *tuck-net* is largely employed, and it may be used any distance from land and over any depth of water. When a shoal of fish has been surrounded the different portions of the lower part of the net are pulled tight together by means of a long "purse-string" passed through rings on the foot-rope. The net is thus "pursed" or "tucked," and the fish cannot escape underneath. The slack of the net is then hauled in until all the fish are collected in the bunt, when the steamer comes alongside, and the fish are ladled on board by means of a bucket.

As already mentioned, the central portion or bunt of these seines has usually a much smaller mesh than the outlying portions or wings. It is also somewhat deeper. In those used for small fish the centre may even be of canvas or calico, as in the sand-eel seines. In Plate I. Fig. 1, a sketch is given of a form of seine which has been much used by members of the Association, especially for small flat-fish.‡ The

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* For fuller description see Holdsworth, *loc. cit.*

† Augur, *loc. cit.*

‡ DIMENSIONS OF *DRAG-SEINE* OR *TUCK-NET*.

Length of wing (from A to D, Fig. 1),	10 fathoms	(20 m.).
,, wide-meshed portion (A to B),	2 fathoms	(4 m.).
,, intermediate portion (B to C),	5 fathoms	(10 m.).
,, small-meshed portion (C to D),	3 fathoms	(6 m.).
,, "bunt" (E to E′),	3 fathoms	(6 m.).
Number of meshes in portion from A to B,	30 to the yard	(31 to metre).
,, ,, ,, B to C,	36 ,, ,,	(37 ,,).
,, ,, in "bunt" and from C to D,	42 ,, ,,	(43 ,,).

Cod-end at E′ may or may not have a short piece of still finer netting *sewed* on.

Number of meshes deep at D and D′ . .	80.
,, ,, ,, A . . .	60.
,, ,, across "bunt" from D to D′	80.

The mode of "setting-up" the net on to the foot-rope is shown in Fig. 2, and to the head-rope in the central portion of Fig. 3. Across the "bunt" and in the fine portion of the net there are four meshes to every "setting." There are therefore twenty "settings" across the "bunt." Across the "bunt" the "settings" are stretched tighter on the head-rope than on the foot-rope, so as to allow more slack in the net underneath. Towards the outer end of the wings the number of meshes on each setting is gradually reduced to three. Small pieces of sheet-lead are fastened to the foot-rope every three to four settings, and small pieces of cork are attached to the head-rope at corresponding distances, but more lead and corks are placed on the "bunt" than on the wings.

The net as a whole is made of 21-ply cotton; the head-rope is of 3-strand hemp, and advantage of this net is its handiness: it may be packed into small compass, and can be worked by two men. It may be used either from the shore or as a *tuck-net* from a boat. The method of working it as a *tuck-net* is the same as that employed by the Danes for their so-called plaice-seines. The boat is moored some distance from the shore, and the net carried round by rowing and the help of the tide in a semicircle—in Denmark a second boat may aid in shooting it—then the net is dragged over the ground by hauling on the anchor-rope. When the boat is close over the anchor, the net is quickly hauled in, care being taken to keep the foot-rope tight and the head-rope slack, *i.e.* to "tuck" the net.

The Danish "tuck-net" and plaice-seines are probably the same as the above, but the lack of any description of them prevents certainty on the point. It is very similar to Petersen's otter-trawl, but has no "funnel" in the bunt. This is an advantage rather than the reverse, because the mesh is already so small that any additional impediment would prevent the water passing freely through the "bunt," and thus inhibit its fishing capability. Pockets are only of use when the apparatus having them is working for some time—an hour or more. In these fine nets for shallow water they are unnecessary as well as an impediment, because the gear is hauled in at short intervals.

Since the ground covered by these *ground-seines*, *plaice-seines*, or *tuck-nets* is necessarily limited, we may endeavour to increase it in two ways—by fixing otter-boards to the end of the wings, or by towing the net between two boats. The former method was adopted some twenty years ago by the Danish fishermen, and will be referred to more particularly later. The latter seems to be an ancient method, and, as it displays the historical development of our modern English trawls, may be briefly described here. It is the ordinary method of deep-sea fishing on the southern shores of Italy (the *cocchia*);[*] of France (*filets de bœuf*);[*] and of Spain (*parejas*).

In the *filets de bœuf* the spread of the net is about 80 feet (25 m.); and, since the boats in towing separate as widely from one

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the foot-rope of 4-strand hemp. At the end of each wing both head-rope and foot-rope are continued out one foot, "hitched" round a pole six feet high, and meet together ten to twelve feet further in an "eye." The drag-ropes, thirty to fifty fathoms long, are fastened to each "eye." A heavy piece of sheet-lead is fastened round each pole just *above* where the foot-rope is hitched on (L).

The complete net as above described costs £5. A larger net of same make, 100 meshes in the "bunt" and twelve fathoms in the wings, costs a little over £6.

[*] Faber, *The Fisheries of the Adriatic;* Gourret, *Les Pêcheries et les Poissons de la Mediterranée*, Paris, 1894.

In the Italian trawls there is a series of four to five hoops, probably of bamboo, which help to support the main body of the long net.

another as possible, these nets may have as wide a spread as our otter-trawls. The wings are somewhat smaller than those of the drag-seine above mentioned, but the bag is of enormous dimensions. From the centre of the head-line to the end of the sac (*culignon*) it measures at least 90 feet (28 m.). As in the drag-seine, the meshes are very small—1 in. at the greatest—and there are no pockets; instead, the *culignon* has the form of a triangle whose apex joins the main body of the net. The base of the triangle, *i.e.* the end of the net, expands at each side into two ears (*anses*), and from the centre of the base two stout cords—one below, the other above—run up through the net to join the foot-rope and head-line respectively. The object of this evidently is to press the fish into the ears and keep them there. There is thus no need for flapper or pockets. The whole contrivance is, however, very clumsy in comparison with the ordinary beam- or otter-trawls.

In the *tartana* fishing of Italy and the *gangui à la voile* of France there is only one boat for each net. The nets differ considerably; in the *gangui* it is similar to the *filet de bœuf;* in the *tartana* it is much simpler, without wings or pockets. Both are alike, however, in having a long pole of wood fixed some little distance in front of the net in order to keep the mouth open. The boat which drags the net drifts with the wind and tide, as is the case with the eel-drift boats of Denmark. In the latter, however, the net has no beam or pole, but the bridles are carried directly to the boat, the one forward to the end of the bowsprit, the other aft to the mizzen boom.

From these somewhat primitive types to the modern English *beam-trawl* * there is a considerable gap, but the beam-trawl is highly specialised, and the early stages are quite lost. It differs from the previous forms in having the top of the net fastened directly on to the beam, which again rests on triangular pieces of iron, called the iron-heads. The honour of introducing this change has been claimed by the fishermen of Barking on the Thames, and Brixham in South Devon. For the later developments, however, the lengthening of the square and introduction of pockets and flapper, the Brixham men seem responsible. Since the description given by Holdsworth leaves nothing to be desired, it is unnecessary to enter into any details of its structure.†

We come lastly to the otter-trawl, the most recent and most efficient of all trawls. Its introduction is of so recent a date that changes and experiments are still being made—on the boards, the size and shape of the net, ground-rope, and so on, so that it seems as if the final form had not yet been attained.

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* For an excellent description of the structure and working of the beam-trawl see Holdsworth, *loc. cit.*

† The size of mesh used in the beam-trawl varies according to the kind of fishing. For whiting the mesh in the square is 2½ in. to 2¼ in. from knot to knot, and this decreases to 1½ in. and then to 1¼ in. towards the cod-end. For ordinary fishing the size of mesh is as in the otter-trawl.

The principle of this trawl, as is well known, is that of the kite, the net representing the "tail," the boards the body of the kite, and the warp the string. When a current of air strikes on the kite it tends to drive the kite as a whole away from the string, but the lower portion, being the larger, tends to go away from the string more than the upper. Hence the head of the kite tends to incline towards the string, and consequently the kite, as a whole, moves upward until it has reached such an angle to the direction of the wind that the forces acting above and below the line of the string are in equilibrium. The otter-boards act in a similar fashion when drawn through the water.

Though the principle of the otter-board had been long known, and in use for carrying out a line from the beach or the side of a boat, it was not until between 1860 and 1870 that experiments were made with it on trawls. The earliest mention I can find is that made by Holdsworth (*loc. cit.*) in 1874, and the invention is there ascribed to a Mr. Musgrave. From other evidence it appears, however, that Musgrave merely introduced the otter-trawl to the notice of Irish fishermen, and that Mr. Hearder, an electrician and inventor of considerable repute, was really the inventor.

One can see from the figure given by Holdsworth that the original otter-trawl invented by Hearder differed from the modern trawls in that the ground-rope was very little behind the head-rope. The boards, however, were fixed up in a similar fashion to those later patented by Scott. These trawls were much used by amateurs, especially from steam yacht's, but it was not till some years later that professional fishermen adopted them.

According to Spillmann,* the captain of an English steam trawler was the first to experiment with them in 1885, but he does not seem to have met with success. In 1886 one Thurlow took out a patent for a peculiar kind of board resting on a small trolley, but this also does not seem to have worked well. In the *Mittheilungen* for 1888, p. 153, a figure is given of an otter-board which is fixed up essentially the same as those now used. It was employed by the Danish sailing craft from Frederikshaven when fishing on the west coast of Jutland. If the wind was suitable they fastened these otter-boards to their long drag-seines (or plaice-seines, see *ante*), and towed the net over the ground ("snurrevaaden"). As the fishing seems to have been successful,* we may ascribe to the Danish fishermen the honour of first using, professionally, the *otter-trawl* from sailing boats.

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* *Mitt. Deut. Seefisch. Vereins*, August, 1896, p. 153.

It was not, however, until 1894 that the *otter-trawl* began to make distinct headway amongst professional fishermen. In that year Scott of Granton, who had been experimenting for several years with the otter-boards, became at last convinced of their utility and took out a patent for boards of his own design. He then fitted up several steamers on his own account and caused them to fish from different English ports in succession. The transformation effected thereby in the fishing apparatus of the English, and later the foreign, steamers was both rapid and extensive; within a few years the old beam-trawls had quite disappeared, except in the sailing craft.† The advantages claimed for the otter-trawl over the beam-trawl were mainly that it had a greater spread, and that its head-line was higher from the ground, so that it should catch more fish and in greater variety.‡ Recent investigations have cast some doubt on the first claim, but the second seems to be well substantiated by the greater catches of round fish which the otter-trawl brings in.

From the figure of Scott's patent otter-boards given by Cunningham in this Journal (*loc. cit.*) it appears that, as originally designed, the ground-rope and head-line met together in a ring at the centre of the hind margin. In all the boards used at the present day they are fastened separately, the former near the foot of the board, the latter near the top. In the present-day boards also, there are three transverse iron bars running across the otherwise smooth front face and bolted through to similar bars on the back. On the latter, one frequently sees two long iron bars placed diagonally across the board. These are used on the boards with chains in place of the patent triangles.

The boards are made of deal wood and are 9 ft. to 10 ft. long by 4 ft. 5 in. to 4 ft. 6 in. high, and 4 in. to 5 in. thick.§ The first iron bar is placed 2 ft. 4 in. to 2 ft. 6 in. from the anterior border and supports the base of the first triangle or "bracket" (see Cunningham's figure). The second bar comes 18 in. further back and supports the second and longer triangle. In working, the two triangles meet about

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* Petersen, *Report from the Danish Biological Station*, iii., 1892, p. 36. *Mitt. Deut. Seefisch. Vereins*, 1888.

† According to Spillmann, *loc. cit.* (quoted by Petersen, *loc. cit.*, 1898), Capt. Nielsen, a Dane, was the first to make the otter-boards a success in 1895. As Scott and probably many others had been successful during 1894, it would have been more correct to say that Nielsen was *one* of the first successful fishermen. It appears further from Spillmann's account that Nielsen was one of the first, if not the first, to avoid Scott's patent by using chains instead of "brackets" on the boards.

‡ Cunningham, "North Sea Investigations," *Journ. M. B. A.*, iv. pp. 114–121.

§ According to Spillmann the boards used in Germany are shorter (7 ft.) and lighter (7 cwt.), but in proportion higher (4 ft.). The English boards are about 9 cwt.

9 in. to 1 ft. from the board and nearer the base of the anterior triangle than that of the posterior. The third iron bar is placed near the posterior margin of the board, a little in front of the two holes above and below for the end of the head-line and the shackle of the foot-rope respectively. Round the apices of the triangles a ring or shackle is passed, which, when the boards are working, is fastened to the last of a series of iron links, six to ten in number, forming the continuation of the warp. The second last link of this chain is replaced by a swivel which serves to take the "turns" out of the warp. In the non-patent boards chains are used in place of the brackets, and they are fastened to the boards nearer to the posterior end, as well as wider apart. The reason for this is that the solid iron brackets of Scott's patent are able to steady the board, though they act on only a small surface. The chains are loose and must, in order to steady the board, be attached as near the corners as possible.

Other forms of boards have been tried, but these are the ones most used. The great difficulty with them all is that when the boat stops towing, or if the warps get slack for any reason, the boards fall flat on the ground. When the strain comes on the warps again the boards, instead of rising to their previous position, may turn right over, and thus put a double turn on the net.

To try to obviate this an otter-board of peculiar shape was patented in Germany in 1897. In this, two large wheels joined by an axle were employed, and in the centre of the axle two oar-shaped spars were fixed—one above, the other below. These spars were inclined at an angle away from the axle, so that the upper should catch the water as the ordinary otter-boards do, and the lower the ground in similar fashion. From the sides of the axle two iron bars extended forward to the inner side, and to the ends the warp was attached. Two other similar bars extended backward to the toe-chain of the foot-rope, and from a little distance along them two chains passed upward and backward to support the pole which held up the head of the net.

Whether these have been successful or joined the majority of patents, I cannot say.

It is still an open question whether the large size of boards used by the trawlers is really necessary. The great resistance they offer to the water and their great weight add considerably to the pull of the net on the warps, and consequently demand more power and steaming on the part of the steamer. Further, the volume of water displaced causes a strong current to rush back against the wings. If this water passed down into the net it would be an advantage, but it is found that even with double meshes on the head of the wings it is necessary to leave a gap between the boards and the net. It might be thought, therefore, that if an opening were made in the centre of the board—which plays little or no part in the rotating motion already described—then the same purpose would be served, and if they had sufficiently large surfaces in front and behind the line of action of the trawl warp, they would act just as well as the ordinary boards. Such boards have been used for some months on the trawl of the Association's steamer *Oithona*, and so far as one can judge, give as good a spread, and are easier to work with than if they were solid throughout.

The *net* of the otter-trawl has gone through several changes since first introduced, and even now there are many differences in detail in different companies' trawls. In comparison with that of the beam-trawl, it has a shorter "square," but this is compensated for by an additional pair of wings on the top, or rather in front. In other words, the beam-trawl net has only one pair of wings—the bottom pair; the otter-trawl net has two. The "bag" of the net is identically the same in both.

The "head-line" is formed of a single rope, which passes from board to board along the front of the net above. It is 3 in. to 3½ in. in circumference, and is usually from 90 to 100 feet long. Before use it must be well soaked in water for some time, stretched, then soaked again. This prevents the rope from twisting itself up or "kinking," as it is called. The best thing for a head-line is a half-used warp or a rope which has seen some service and had the "kinks" taken out of it.

The "square" is the central portion of the net which overhangs the ground in front of and above the ground-rope in trawling. It is so-called, I imagine, because it is the nearest approach to a square piece in the whole net. The "top of the square," *i.e.* the portion immediately behind the head-line and the "top-wings," has 300 meshes across (sometimes as many as 330). The "bottom of the square," the portion immediately above the inner edge of the "ground-rope," has 200 meshes across, and down each side there are from 100 to 120 meshes, according as one has a square of 34 or 40 feet long. The size of the mesh is the same throughout, namely, 3 in. from knot to knot, or "four fingers' breadth," as the fishermen say.

The "top-wings" are the outlying portions of the net which extend forward from the square on each side to the top part of the boards. They are of a peculiar triangular shape, with a broad base of 100 meshes joined on to the head of the square, and an apex of only 6 to 12 meshes at the boards. Each may be from 31 to 35 feet long, according to the fancy of the fisherman for a long or a short square. These parts are made to suit one another and the lower portion of the net. As the latter seldom varies, it follows that the top-wings must vary inversely as regards the square. The mesh of the top-wings is usually the same as that of the square, viz. 3 in., but sometimes it is only 2½ in.

Measuring along the side, the top-wing and the square taken together are 65 to 70 feet in length, and this consequently is the length of each "bottom-wing."* These form the lower portions of the trawl-mouth. In front, they are fixed to the ground-rope; at the sides, to the square and top-wings; and behind, to the head of the belly. In shape, they are long, comparatively narrow strips, which are about twice as broad (or deep) at the lower or hind end as they are at the upper or forward end. Where they join on to the head of the belly they measure 50 to 55 meshes across; at the forward end next the boards they are from 25 to 40 meshes. Some men prefer a deep lower wing with 40 meshes in front; others like it narrower. The size of mesh is again 3 in. from knot to knot.

When we come to the "bag" of the net we find that the upper and lower portions are exactly alike, so that as they come ready-made from the makers, it is impossible to distinguish them; and one may be used for the other. Formerly, ten more meshes were allowed in the head of the top portion than in the lower, as is always the case in the beam-trawls; but nowadays the nets are shaped and fixed differently, and the ten meshes are unnecessary. The upper and lower portions are thus alike, and each is divisible into two. The first part, where the number and size of the meshes are being reduced, is called the "batings" when above, "belly and batings" below; and the second part, which is the end of the net, is the "cod-end" or "cod."

The "batings" start with 200 meshes across where they join on to the foot of the square and work down to 60. The size of the mesh to begin with is 3 in. from knot to knot, and this is reduced to 1½ in. The distance between the 200 mesh and the head of the 60 is 34 to 36 feet measured along the side; and the "cod-end," which is uniformly of 60 meshes across, is 12 to 18 feet long. The length of the "bag" is thus from 46 to 50 feet.

In the "batings" the reduction of the size of the mesh and of the number of meshes across is made as gradual as possible. For the first 8 feet the mesh is still 3 in. from knot to knot, but "batings"† are made on each side, so as to reduce their number. At the end of 8 feet the mesh is reduced in size through 2 feet to 2½ in. The batings continue with two knots between each, and the mesh is also gradually reduced until at 18 feet from the foot of the square we have 120 meshes of 2 in. across. This marks the "head of the pockets." The size of mesh is now reduced to 1½ in., and the batings continued until the "cod" of 60 meshes across is reached. The "cod" is open at the end across the whole 60 meshes. A loose double mesh is braided on at the end, through which a rope is passed. When the cod-end is fastened, this rope is pulled tight at both ends and then fastened in a peculiar and handy knot, which only the true trawler knows. The "flapper" is a short tongue of netting of 1½ in. mesh, 40 to 50 meshes at the top down to 20 or 22 meshes at the bottom.

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* This is the length of the bottom-wing when fixed to the square and top-wing. In reality, it is some 4 to 6 feet longer. See p. 578.

† A "bating," *i.e.* reduction, is where two meshes of the preceding row are taken into one mesh. A "creasing" is where an extra mesh is inserted. "Braiding" is the process of making a net. To braid one "round" is to go once across the net. This closes the half-meshes of the preceding "round." Therefore two rounds are required to make one "row" of meshes. The "batings" and "creasings" constitute the puzzle and the artfulness of the net.

The different parts of the net have now been described. It remains to show how they are "fixed" or put together. The "fixing" is the secret of the successful working of the net. By diverse signs one learns to know that the net is too tightly pinched at one part or too slack at another. After a new net is placed in the water it may shrink unevenly—and usually does—and the net will not fish properly. In all cases, when from some sign one suspects the fixing to be wrong, it is better to take the net to pieces and set it up afresh. There is nothing more tantalising than a badly fixed net.

As it comes from the makers the net is in separate bundles, viz. a pair of top-wings, a pair of bottom-wings, the square, a pair of batings and a pair of cod-ends. Unrolling the top-wings and the square, these are braided together, as shown in Plate I. At the side, it is usual to join them by double twine so as to strengthen the corner of the net. The lines of junction of the top-wings to the square are called the "top-quarters" (Plate II.).

The foot of the square is then braided on to the head of one of the batings, and one of the cod-ends to the foot of the latter. The flapper is now taken and *laced* on to the lower part of the batings where the latter is 90 meshes across. The top part of the net is now ready for fixing on to the lower part. As sent out from the makers the bottom-wings are joined together at their broadest part by three to four rows of meshes of double twine. There should be 100 meshes across from wing to wing, and these form what is called the "bosom." The bosom in the centre and the wings at the sides are to be braided on to the head of the belly or batings, and on the lower end of these is braided the remaining cod-end.

The two halves of the net are now prepared for lacing. This is done by hitching them up to a post, or an eye on the bulwarks, and stretching them out parallel to one another—the flapper on the inside, of course—so that the meshes along the side—"selvage," it is called—correspond above and below. In lacing it is better to begin at the cod-end and work along to the wings, because the "bag" must be uniformly alike above and below, whereas a little slack, which may show itself in the lacing, does not matter in the wings. The selvage is of double twine both above and below, and the lacing strings, also double, should take in two to six extra rows of meshes. There should be little chance, therefore, of the net breaking away in the selvage.*

When both sides of the net are laced up, the lower portion should be stretched out flat and the pockets put in. This is done by getting hold of the net where it is 120 meshes across, and lacing the top to the bottom part across the first three meshes on each side, then down some ten feet along a line of the network. As the lacing proceeds, the first two meshes of the sides of the flapper are taken up and laced in between the bottom and top part of the net. At 90 the pockets end, but the flapper is laced down to the belly some two feet further along the same line of network. About six rows of the flapper are left free at the end. By lacing the flapper down to the belly a free space is left above, between the flapper and the top batings, so that when fish get behind the flapper and try to strike back they will enter this space first of all, and thence be guided into the pockets.

When the trawl is laced up the last operations consist in fixing on the head-line and foot-rope. The "foot-rope" or "ground-rope" is a very large and expensive structure in the modern trawls. It has a central core of "2½" in. wire covered by old netting from mackerel or herring nets, and this is rounded with old manilla trawl warps. When complete it measures about 10 in. in circumference and 120 to 138 ft. long.

In order to fix on the ground-rope, the centre of the bosom should be found and hitched up on a pole as before; the wings are then stretched parallel to one another and their ends hitched up to another pole. The "balch" or "balch-line," or rope 1½ in. in circumference which comes between the ground-rope and the net, is then hitched up at its centre to the first pole and both sides stretched out parallel to some distance over the parallel wings. The bosom of the net is then "marled" on (Fig. 3) directly to the balch. The wings, however, have what is called the "flying-mesh" along the inner side (Fig. 3), and the balch is fixed on differently. A "wing-line" of the ordinary net-twine, but doubled, is passed through each flying-mesh, as shown in the figure, and then marled on to the balch-line. The flying-mesh for the wings is an ingenious contrivance. The part most liable to injury from stones or "ross" on rough ground, is the first two to three rows immediately behind the foot-rope. The more yielding or "give" the meshes in these rows have, the more likely are they to jump the obstacle or break it off. This greater elasticity is provided for by the flying-mesh. It is specially useful in the wings, because any obstacle that catches the net will there strike the mesh on the side, *i.e.* at its weakest part, and might break *across* a long series of meshes. Such a tear is about the most awkward to mend the fisherman can have. With the flying-mesh the tear tends to be *along* the mesh, *i.e.* the course of braiding, and it is soon mended. It is evident further that in the bosom the flying-mesh is unnecessary. The ground-rope is next made fast and stretched out as was done to the net and balch, and the balch is then fastened or "balched on" to it. As a rule 10 to 20 ft. of bosom are allowed on the foot-rope, so that the 100 meshes are to be gathered together, in threes, and their balch-line distributed uniformly over the 10 to 20 ft. The fisherman is guided by the turns in the rounding of the ground-rope where to fix the "setting." It is generally every third turn for the balching of the bosom. In balching the wings the foot-rope is often marked by chalk-lines where the settings have to go. Experienced hands, however, are guided by the turns in the ground-rope, about every seventh to begin with, until they see how much slack they have, and then fix according to their liking. Three to four of the "staplings" on the balch-line are included in a setting, and the settings are wider apart near the end of the wings than at the quarters.

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* When heavy "bags" are experienced, a 2-in. rope is laced in with the selvage.

The head-line and the top part of the net are set up for balching in a similar fashion, but there are no flying-meshes * nor balch-line. The square and the top-wings are marled on directly to the head-line with double twine. The square has very little slack given it; the slack is put into the wings. The result of this is that when the trawl is moving through the water the wings are greatly distended at each side, thus tending to keep the mouth of the bag open wide. If the slack were put into the head of the square, the head-line would dip in the centre from the weight of the net behind.

When the net has been fixed in the fashion described, attention has to be paid constantly, when fishing, to the condition of things at the quarters. These are where the square and top-wings (or belly and bottom-wings) meet on the head-line (or ground-rope). These are made specially strong with double meshes, as already described; and if the net has been badly fixed or shrinks unequally, they soon show it. If the square is too much stretched, it will break away from the head-rope at the quarters; the top-wing has then to be unlaced from the bottom-wing on the side where the break occurs, more slack given to the square at the quarters, and the whole laced up again.

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* The flying-mesh may also be present in the top-wings.

Some of the finer details in the structure and fixing of the net may now be pointed out. It will first of all be noticed that whilst the head-rope is only 90 feet long, the length of the wings and head of the square which fix on to the head-rope is more than 105 feet, that is to say, 15 feet of slack must be distributed along the two wings. This means that the square is stretched out in the centre as far as it can stretch. The batings are consequently stretched out in the centre, and likewise the cod-end. If we turn to the under part of the net we find the same thing. The ground-rope is 120 feet long, but the length of net to be attached to it is over 160 feet. This means that the centre of the belly must be pulled up, even though plenty of slack is allowed. Consequently, there is a strain down the centre of the net, both above and below, from the front to the cod-end; and this does away with the necessity for having guy-ropes leading from the head-line and foot-rope to the cod-end, which are present, as mentioned before, in the *filets de bœuf.*

On the other hand, the bag-formation at the sides, which the Frenchmen obtained by means of these ropes and the ears (*anses*) in the "cod-end" (*culignon*), is given in the otter-trawl by a careful distribution of the slack along the sides. The top-wing and square measured along the side are about 70 feet long; the bottom-wing to which they are laced is 5 feet longer. This 5 feet of slack must be put in somewhere, and as it is usual to allow the square two or three of slack in order to relieve the strain on the net and put it on the head-rope, we must distribute the 8 feet of slack on the bottom-wing along the selvage of the top-wing. It would seem, therefore, as if the meshes of the top-wing ought to be stretched, but, as already pointed out, it has about 8 feet of slack along the head-line. The bottom-wing, relatively to the head-rope, has consequently about 16 feet of slack net, and relatively to the foot-rope it has more than 20 feet. The result is that the net must bulge out to the side and also backward, and this is the case with the under part of the net more than with the upper.

As we follow the lines of the bag of the net from the 120 mesh towards the cod-end, it will be noticed that the inner sides of the pockets really continue the sides of the net, and the opening under the flapper is the termination. The remaining portions, formed by the pockets and cod-end, are just as if they had been tacked on separately. When the net is fishing, therefore, there is nothing at the sides to stop the flow of water or cause an eddy, but a smooth passage right down into the cod-end. The rush of water into the latter must be of considerable force, and as it enters it must divide into two streams—one to the right, the other to the left, because it cannot pass through the knot by which the end is tied.

The water in the cod-end tending to escape at the sides and above, forms an eddy in the direction of the pockets. That this eddy must be fairly strong is shown by the practice of the fishermen in having a long cod-end. If the cod-end is short and dirt gets in, the fishermen get no fish, and ascribe this to the dead-water or back-wash which gets above the flapper and closes it. And as evidence of this one may find some dirt or weed hanging above the flapper.

With respect to the cod-end, it should be mentioned that rubbers are laced to it underneath to prevent the net being chafed on the ground. They are made from old net cut into strips two to four feet long, and the breadth of the cod-end. They vary in number from four to eight, according as the ground is smooth or rough. On smooth ground, indeed, they are not necessary.

It has been shown above that there is a strain upon the meshes of the net along the central line both above and below. One result of this is that the meshes of the square must be wide open; and since the meshes there are large in size, many fish must escape through them. By Dr. Fulton's experiments * with cod-ends of various sizes of mesh it has been shown that more fish escaped than were captured with the ordinary cod-end mesh of 1½ in., and when a mesh of 2½ in. was used all except the very largest got through. A few years ago, also, it occurred to the men of the smaller Brixham trawlers that many fish, especially whiting, must escape through the top of the net, which at that time had a mesh of 2½ in. in the square and head of the batings. To test the point they laced a portion of a herring net over the square and batings, and found, just as they expected, that they caught more fish in the herring net than in the trawl. They consequently reduced the mesh to 2¼ in. and 2 in. in the square, and 2 in. in the batings. Even with this size they find that a great number of intermediate size of whiting—9 to 10 in.—are meshed in the batings whilst trying to escape.

It follows from these experiments of Dr. Fulton and the Brixham men that only a very small proportion—less than 10 per cent.—of the round fish are taken by the otter-trawl from the water which it passes through. Some might wonder why the fishermen use such a mesh in the top part of the net as will allow the largest haddock to escape, but the large mesh is really a necessity in the trawls as now constructed. It is different for a beam-trawl, where the mesh can be suited by the speed; but with the otter-trawl the smaller speed which

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* *Rep. Scot. Fish. Board*, xix., for 1900, part iii. p. 62.

is demanded by the smaller mesh would mean that the otter-boards would not spread out satisfactorily, and the net consequently would not fish well, if at all. On the other hand, if the meshes of the square are open to their fullest extent, it is different with the meshes in the wings. As a result of the "slack" at the sides, the meshes there will be extended lengthwise and not so fully open as in the square. The result is that the main rush of water down into the bag is along the sides, and this should be the path the majority of the fish caught in the net will travel.

The greatest difficulty in the working of the otter-trawl is to ensure that the head-line is well off the bottom. If it tends to sag in the centre, the results of the fishing will show that for one thing, and if it bends so far as to touch the ground the rope will be frayed or have some dirt on it. If the mesh in the square were smaller the force of the water when it passed *under* the head-line would tend to raise the net, but the objections to the smaller mesh are twofold: firstly, if the head-line sagged in any part the pressure of the water would act on the net *above* the head-line and thus drive it down; and secondly, the smaller the mesh the greater the resistance to the water, and the greater, therefore, the "wave" in front of the net. In neither case would the fishing be a success.

Various patents have from time to time appeared with the intention of overcoming this difficulty. In Epton's patent two large air-bladders, with coating of rubber and surrounded by netting, are fastened one to each top-quarter. In another patent an air-bladder of similar material, but tubular in shape and some 6 to 10 ft. long, is attached to the net over the centre of the head-line. It is said by some, however, that the resistance these offer to the water is appreciable. Tanner's idea,* which has been adopted by Petersen and Hjort, to fix glass spheres enclosed in netting round the head-line, would hardly do for professional fishermen. The most recent patent, and one which seems most likely to be successful of any yet tried, is to attach two small otter-boards to the top-quarters and to the main otter-boards in such a way that they would tend to rise in the water, and therefore pull up the head-line.

Another difficulty lies in the choice of the right size of ground-rope to use, though it has been more experienced by naturalists and sailing trawlers than the steamers. In the sailing trawlers the wind may be so light that the boat cannot pull the ground-rope over the bottom fast enough, and mud or stones getting into the net may tear it to pieces. Sometimes also, even with a good breeze, the trawl may come upon a bank of sand or mud which reaches higher than the beam and means ruin to the trawl. Similar difficulties and experiences have been encountered in the use of Petersen's trawl, but, as will be shown presently, these arise in this case from the nature of the trawl, which, as constructed, courts disaster on soft ground.

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* *Bull. U.S. Fish Commission*, xvi. 1896.

Hjort (*loc. cit.*) has endeavoured to overcome this difficulty in the latter by fixing a stone to the under part of the ground-rope in the centre and counterbalancing it by means of a glass globe above, the idea being, that if the weight of the stone is taken off by rising ground, then the glass globe will lift the ground-rope out of harm's way. Though one would imagine that the stone, by sticking in the mud, would drag the rope down into it likewise, Hjort seems to have found the method successful. Petersen suggests that a thick coir rope should be fastened on the foot-rope when trawling on soft ground, and indeed, the only thing that can be done with Petersen's trawl, if one wishes to use it on soft, muddy ground, is to make the ground-rope as light as possible and as large round as possible, then tow over the ground as fast as the trawl will permit. Such is the method of the steam trawlers. They have no special fear of muddy ground, but take care to increase the speed of the vessel.

The otter-trawl, by the large meshes of the net, the thick ground-rope, and the high speed it must be towed at, is well adapted for soft ground. A greater difficulty is met with on hard or stony ground. It is essential for good fishing that the ground-rope should grip the ground to some extent, and in order to do this on hard ground all trawlers, whether sailing or steam, reduce speed and at the same time shorten the warps. To do this successfully demands great skill and experience, and in the latter respect the beam-trawlers are many years ahead. It is said, indeed, that they work constantly on rough ground, which the steam trawler avoids after one or two trials. The reason is not far to seek. On rough ground, the roughness is caused not merely by stones, but also by the animal life present, as *Lepralia* ("Ross"), *Alcyonium* ("Dead Men's Fingers") on Oysters, Pectens, and such like. The ground-rope of the otter-trawl is quite able to get over these, but their sharp points tear the meshes of the net. The sailing trawlers and the steamers have different devices for overcoming this difficulty. In the former a series of iron rings is suspended all along the ground-rope, and between each ring hangs a short iron chain. There is thus a series of festoons hanging underneath the ground-rope which, at one and the same time, helps the rope to bite into the ground and to break up the material which causes the roughness. To my knowledge, this device has not been adopted, though it may have been tried, on any of the steam trawlers; probably because the great weight the chains add to the foot-rope would cause the otter-boards to approach one another, and thus effectually spoil the fishing. Instead, they use a series of "bobbins" or rollers in place of the ordinary bosom of the ground-rope. These are of two sorts—a large, about 15 in. in length by 12 in. in diameter, and a small, about 6 in. by 4 in. The small rollers alternate with the large, and serve for the fixing of the settings of the bosom. Each roller has an iron "bush," *i.e.* a hollow tube through the centre, and through this is threaded the iron wire which forms the core of the ground-rope. Since these bobbins are not always in use, it is necessary to have some arrangement by which they can be readily shipped and unshipped, and this is done in the following manner. The ground-rope is made in three pieces, and the central part, about 20 ft. long, is shackled on to the wings. When the bobbins are to be used, it is a simple matter to unshackle the ordinary bosom of the ground-rope, and shackle on the wire rope with the bobbins.

These add very little, if anything, to the weight of the ground-rope, and are better able to surmount obstacles and break up the hard material on rough ground.

Having thus described the structure of the otter-trawl in detail, it may be of interest to compare it more particularly with other forms of trawls, so as to display wherein its advantages and its limitations lie. It has been shown that the otter-trawl and the beam-trawl are alike in the structure of the bag, batings, pocket, and cod-end, and in having a large square projecting in front. In these particulars they differ from all other forms, and show a distinct improvement. The advantage of the square is that the fish which are feeding on the bottom fauna are well into the net before being disturbed by the ground-rope. If the latter is in advance of the head-line or on a level with it, as in the *filets de bœuf* and Petersen's trawl, for example, very few of the swifter forms will be captured. Such has been our experience during the past year. The first trawl employed on the Association's steamer *Oithona* had a square only 8 ft. long, and whilst it was an excellent instrument for catching plaice and soles, it was useless, comparatively speaking, for whiting. They were caught, but in no great quantity. Later, when a 24-foot square was used, the whiting were well represented. As pointed out by Dr. Fulton,* the presence of long wings, and, I may add, the absence of a square, is one of the serious defects of Petersen's trawl.

The advantage of the flapper and pockets, and of the mode of fixing the net which makes them functional, is that once the fish are in the bag of the trawl they cannot escape. In the *filets de bœuf* and similar nets of the Mediterranean, the bag is exceedingly long, and contracts about 10 ft. from the end, like the old-fashioned silk purses, and then expands into the *culignon*. A great length of bag is here necessary in order to make the net contract and retain the fish. Another method, formerly used in the beam-trawls of this country, was to make several pockets up each side of the net, without a flapper. A further method is that used in the shrimp-trawls of the scientific expeditions of the United States, and adopted more recently by Petersen. It consists of a cone, or funnel, which is laced at its broad end near the front part of the bag, the narrower end hanging open and free towards the cod-end. The under part of this funnel is obviously of doubtful use. It must lie on the belly of the net when trawling and is consequently of no service. If the sides of the funnel were laced along the belly, as described here for the otter-trawl, the under part could be done away with. It is probable, however, that Petersen's trawl would fish just as well without the funnel as with it.

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* *Ann. Report Scot. Fishery Board*, xx. p. iii. p. 329.

Of the various methods for retaining the fish within the bag, that used in the beam- and otter-trawls seems by far the simplest and most efficient. If the net is properly constructed and properly fixed the fish should have no difficulty in getting into the cod-end, and once there their natural and well-known tendency to strike upward raises them above the flapper, and they thus cannot escape back into the net. The short bag that is necessary is also a great advantage, as it saves a great deal in the making and repairing of the nets.

The otter-trawl and beam-trawl differ from one another so little that the one may be converted into the other. Remove the beam and iron-heads from the latter, braid on a pair of top-wings to the square, and extend the lower wings correspondingly, and we should have a fairly good otter-trawl. The few differences are of minor importance and are concerned with the kind and manner of fishing. It follows from thence that the results of the fishing depend upon the shape and size of the mouth of the trawl. In the beam-trawl the mouth is rectangular—30 to 40 ft. broad or more, and 3 to 4 ft. high. In the otter-trawl both the height and breadth are still uncertain. According to the experiments made by Fulton * the breadth from board to board varies between one-half and two-thirds of the possible spread, *i.e.* a trawl with 90-foot head-line will have a breadth of mouth between 45 and 60 ft. In this respect, therefore, the otter-trawl has only a slight advantage over the largest beam-trawls in use. With regard to the height of the centre of the head-line we have no data on which to base a calculation. If the trawl-mouth is open properly it may vary between 5 and 15 ft., and the fisherman's estimate of 10 ft. is probably near the mark. This seems to accord with the opinion

* *Loc. cit.*, pp. 120, 121.

generally held by trawlers, and indicated by the calculations of Garstang* and Fulton,† that the otter-trawl catches about 30 per cent. more round fish than the beam-trawl, but the same amount of flat fish. Whatever reliance may be placed on these conclusions, and they are admittedly based on indirect evidence, it is certain that the otter-trawl is not so adaptable for catching flat-fish as the beam-trawl. The high rate of speed which is necessary in the former case in order to keep the mouth of the net open, detracts from its power of catching flat-fish. If the speed is reduced the spread of the mouth will fall below that of the beam-trawl, and the same thing would occur if any extra weight, such as an iron chain or dangles, were attached to the foot-rope as in the beam-trawl, in order to stir up the fish. With respect to size of mesh, also, the otter-trawl is at a great disadvantage in comparison with the beam-trawl. A smaller mesh means less speed, and this, as shown, distinctly affects the fishing capacity of the former, and that adversely, whereas if it affects the beam-trawl it is favourably. The head of the net in the latter is always a fixed height from the ground, and the reduced speed that the smaller mesh demands does not affect the spread.

There can be no doubt, therefore, that for certain purposes the beam-trawl is preferable to the otter, and more especially for small flat-fish. Petersen's trawl, for example, is exceedingly well adapted for this purpose, but it would fish better, I think, and with less trouble, if a beam were attached to it. Its utmost spread appears to be 16 ft., but in practice it is probably less, whereas if it were converted into a beam-trawl its spread would be constant and assured. The small size of its mesh—less than 1 in.—makes it comparable, not to an otter-trawl or ordinary beam-trawl, but to the well-known shrimp-trawl. In the latter the beam may be of any length between 8 ft. and 24 ft., and its height from 15 in. to 2½ ft. The size of mesh varies from 1 in. down to ¼ in., and in formation the net may be exactly as the ordinary beam-trawl. In place of a wooden beam, however, a hollow iron pipe is better. For deep-sea work in depths greater than 20 fathoms Agassiz' modification of the shrimp-trawl is very useful, because it is immaterial which side it falls on.‡

The average speed at which the otter-trawl is towed over the ground is 2½ knots per hour, the beam-trawl 2 knots, and the shrimp-trawl

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* *Journ. M. B. A.*, vol. vi. p. 50.

† *Loc. cit.*, pp. 122–5.

‡ *Bull. U.S. Fish Commission*, xvi., 1896, p. 357. Petersen (*loc. cit.*, p. 6) would have it that the Americans are inclined to return to the single form of shrimp-trawl, but this does not seem warranted. Petersen has slightly misquoted the words of Tanner in the Bulletin cited. According to Tanner, "experts" are able to land the ordinary shrimp-trawl right side up in deep water; Petersen has it "investigators." There is here a distinction as well as a difference.

1 mile; it varies according to the ground, the size of mesh, and the length of warp. On hard ground or with smaller mesh or shorter warps it is less than stated, but may be greater with larger mesh and greater length of warp, especially on soft ground.

The dimensions of the commercial trawl-net may be summarised in more compact form:—

Square: 34–40 feet long, 300 meshes down to 200; mesh 3 in.
Top-wings: 31–35 feet long, 100 meshes down to 6 or 12; mesh 3 in.
Bottom-wings: 68–78 feet long, 50–55 meshes down to 25–32; mesh 3 in.
Batings: 200 meshes down to 60; length, 34 to 36 feet (18 feet to "head of pockets," 10–12 feet of pockets, 6 feet 90 meshes down to 60).
Belly and Batings: like the Batings.
Cod-end: 60 meshes across; 1½ in. mesh; 12 to 18 feet.
Head-rope: 90–100 feet.
Ground-rope: 120–130 feet.

Inasmuch as the ordinary commercial otter-trawls are often too large for the steamers at the service of naturalists, it may be of use to give the dimensions of a trawl with 64 feet head-line such as used on the *Oithona*:—

Square: 26 feet long, 280 meshes down to 180; mesh 2½ in.
Top-wings: 25 feet long, 80 meshes down to 10; 2½ in. mesh.
Bottom-wings: 54 feet long, 50 meshes down to 30; 2½ in. mesh.
Batings; 180 meshes down to 60; 24 feet (first 10 feet to the head of the pockets, 10 feet of pockets, 4 feet 90 meshes down to 60); the size of mesh is graded as in the big trawls.
Belly and Batings: 170 meshes down to 60; the details otherwise being the same as above.
Cod-end: 60 meshes across in its whole length; 1 in. or 1½ in. mesh; 8 feet long.
Head-rope: 64 feet.
Ground-rope: 90 feet.

The fixing is just the same as in the large trawls, the square being balched tight to the single head-rope, and 7 to 10 feet of bosom allowed. The ground-rope is 7 in. in diameter, and has a central core of iron wire except in the centre of the bosom.

The best method of curing or preserving a net made of manilla twine is to soak it in coal-tar, but if the net is of cotton this makes it unnecessarily heavy, and either cutch alone should be used or cutch once or twice, and then light green oil, *i.e.* creosote oil. The heavy oil of tar, commonly called green oil, is also useful. For hemp nets, cutch and coal-tar seem the best methods. Manilla is employed where rough work has to be done, as in the otter-trawls and larger beam-trawls; cotton and hemp in the smaller beam-trawls and shrimp-trawls.

In the paper referred to,* Dr. Fulton discusses the probability of pelagic fishing with trawls, and concludes that the ideal should have two pairs of otter-boards, so that the mouth and net itself is square-shaped. The practical men, however, seem to have dissuaded him from trying this. As a matter of fact, such a net was experimented with in the North Sea a little more than two years ago with some measure of success.

DESCRIPTION OF DRAWINGS.

Plate I. Fig. 1.—Drag-seine or Tuck-net, see footnote, p. 567.
Fig. 2.—The method of fixing (balching) a balch-line (*b*) by means of settings (*s*) on to a head-line or ground-rope.
Fig. 3.—The method of fixing (marling) the head of the square on to the head-line, and the "flying mesh" in the wings.
Plate II.—Ground-plan of Otter-trawl.

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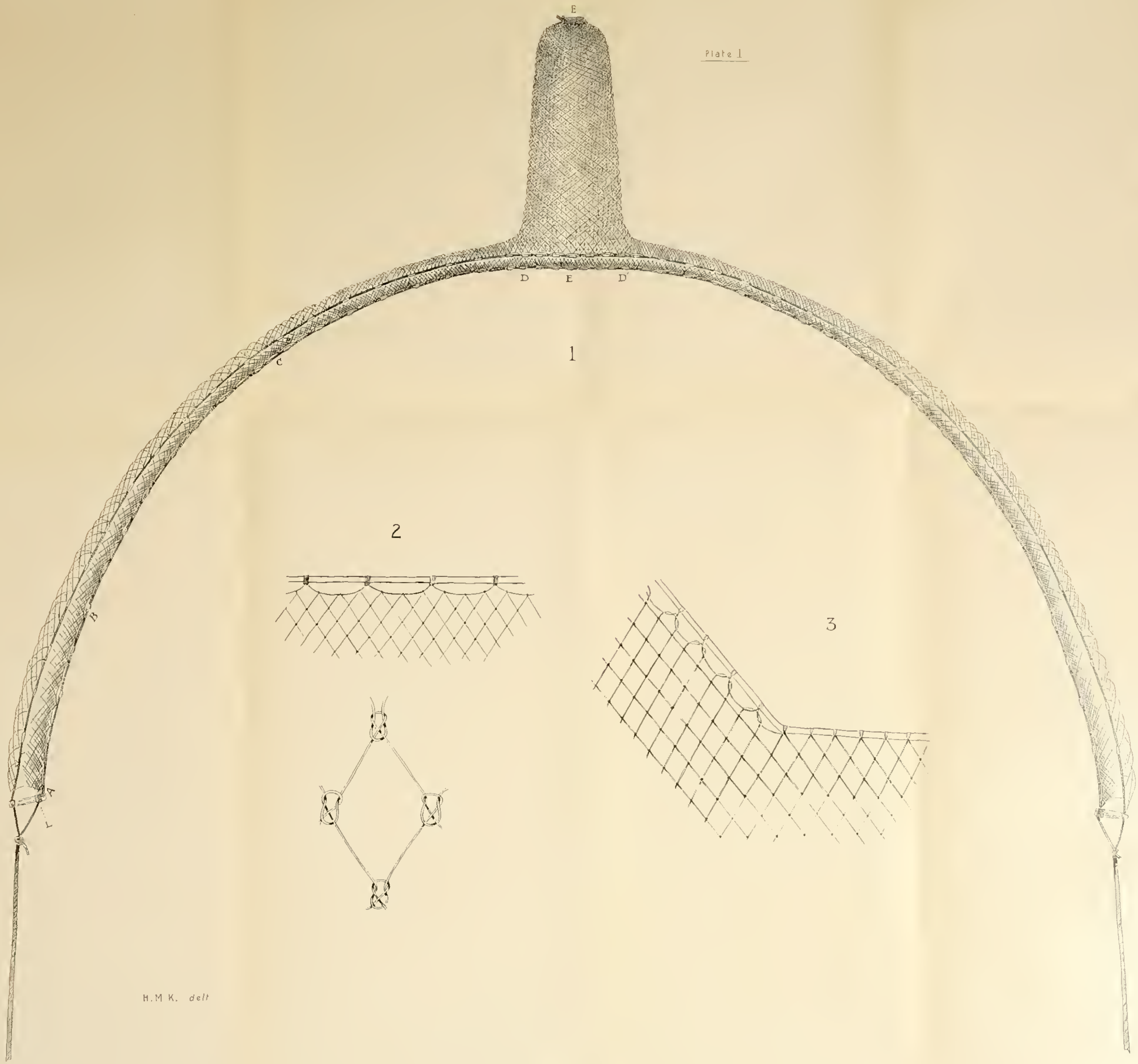
* *Twentieth Report*, pp. 329 and 330.

Plate 1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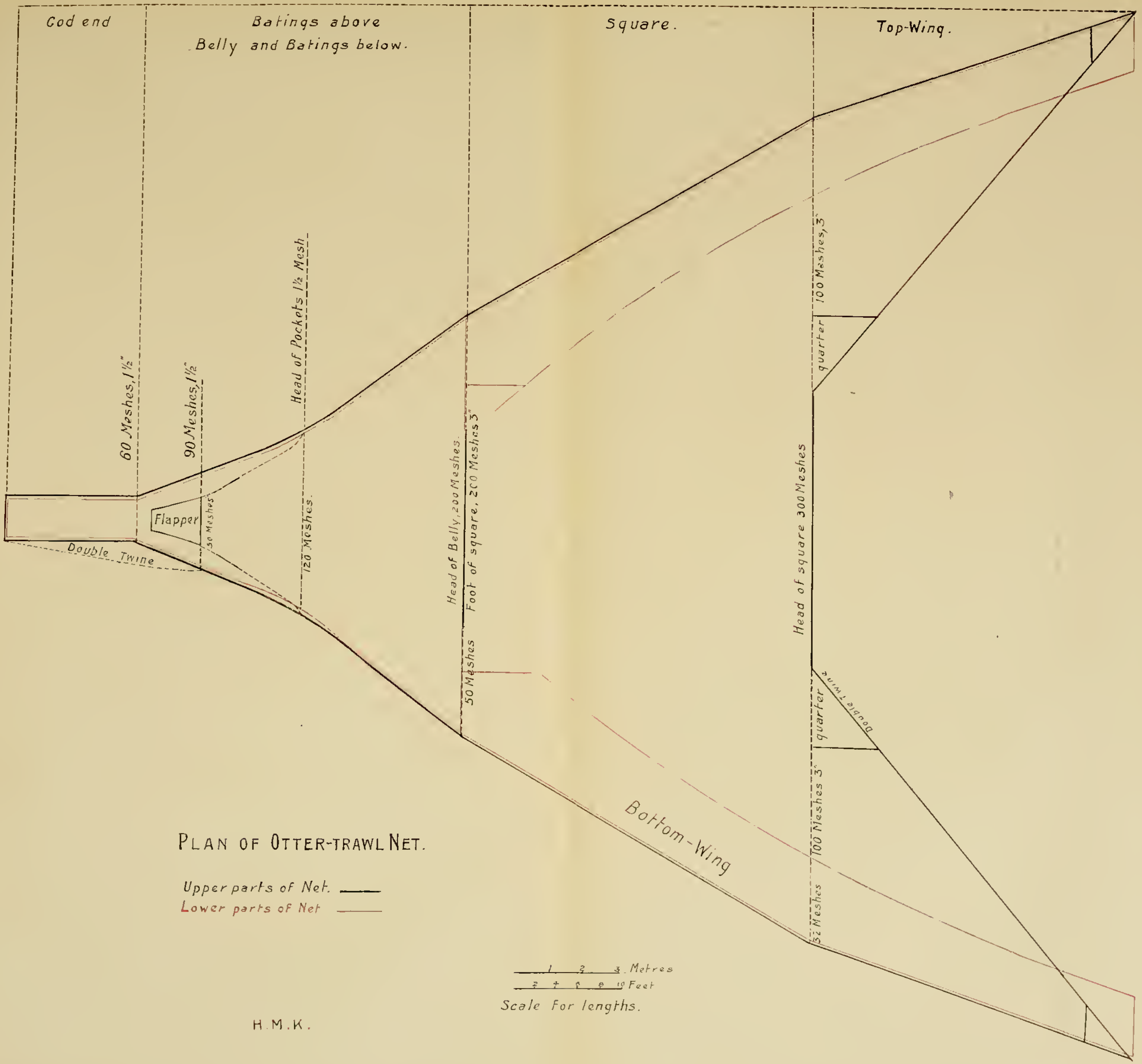
Cod end
Batings above
Belly and Batings below.
Square.
Top-Wing.
60 Meshes, 1½"
90 Meshes, 1½
Head of Pockets 1½ Mesh
Flapper
30 Meshes
120 Meshes.
Double Twine
Head of Belly, 200 Meshes.
Foot of square, 200 Meshes 3"
50 Meshes
100 Meshes, 3"
quarter
Head of square 300 Meshes
Double Twine
quarter
100 Meshes 3"
32 Meshes
Bottom-Wing
Upper parts of Net.
Lower parts of Net
1 2 3 Metres
2 4 6 8 10 Feet
Scale for lengths.
H.M.K.

PLAN OF OTTER-TRAWL NET.

What is Over-fishing?*

By

Dr. C. G. Joh. Petersen, Copenhagen.

(With one Diagram.)

FOR the sake of argument I will suppose:

I. That in a biologically self-contained area, *e.g.* in the North Sea, statistics show that the value of the total yearly catch of a certain species of fish is decreasing year by year;

II. That the catching power and the prices are not reduced;

III. That the physical conditions have not changed in an unfavourable manner.

The decrease must then be ascribed to organic factors, either to man or to other organisms.

If the decrease must be ascribed to man solely, or in some degree, over-fishing has taken place.

It will be understood that over-fishing cannot easily be proved with regard to many species of fishes, *e.g.* for true migratory fishes. For example, in the case of the herring and the cod statistics have always shown great fluctuations. For this reason it is necessary that statistics in the case of such fishes should extend over a very long time to prove any decrease beyond the ordinary fluctuations. In dealing with other fishes, *e.g.* the plaice, the statistics do not fluctuate so much because the plaice is not so migratory. However, if we had statistics alone to depend upon, the problem concerning the influence of man would never be solved. Any decrease might always be ascribed to some or other imagined reasons. Fortunately we can get more than statistical data to rely upon.

It is not my intention here to discuss all problems about over-fishing, this being impossible. I only wish to give an example in order to throw light upon some of the principal ideas concerning this matter.

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* This analysis of the problems of over-fishing was prepared to meet a desire expressed by several members of the International Committee on Over-fishing during the last meeting of the International Council at Copenhagen.—W. G.

Accordingly I take the case of an imaginary fish, species "P," which exhibits the following features:—

1. It does not migrate out of the North Sea.
2. It takes three years to grow up to maturity (see Diagram).
3. It is nearly in every respect closely allied to the plaice.

The stock of this fish "P" has, during recent years, been reduced in the Kattegat and in the North Sea to such an extent that statistics prove that the weight of "P" annually caught is not at present so great as formerly, in spite of the catching power being highly augmented. Had not the prices per kilo increased during the same period, nearly all "P" fishing would have been stopped, at least in the Kattegat.

Now somebody may say, "Well, you have had to do with a stock of 'P' accumulated during many years. The III Group (Diagram, IIIa) was accumulated and included all 'P' of three years and above, possibly up to twenty years, the maximum possible age of a 'P.' In the very beginning you were catching these old III individuals, but this cannot be done every year, since a larger stock will grow up in twenty years than in one. This fact is the explanation of your decreasing statistics."

This *status quo* may occur in Norwegian fjords, where the areas in which the I or II Groups live are very limited, and where the number of individuals in these groups is consequently small compared with those in the III Group. The individuals of the I and II Groups are very fond of shallow, sandy beaches, but those of the III Group live in much deeper water. Fishery investigations in such fjords have proved that the III Group is really much easier to catch in numbers than are the I and II Groups, and that the average size of the individuals of the III Group is thirteen to fourteen inches (Diagram, IIIa). This example of an annually decreasing catch is not strictly an example of over-fishing, at any rate it is only an exceptional kind of over-fishing, which is inevitable, and to some degree desirable.

An explanation of this kind, however, cannot be used to account for what has happened in the North Sea and in the Kattegat during recent years, since the fishery of "P" in this area is no longer based upon the III Group, but upon the II Group. If we consider numbers instead of weight, the greater part of the total annual catch is now, and has been for many years, made up of individuals of the II Group with comparatively few of the III Group. The average size of the III "P" has, moreover, during the same time gone down from thirteen or fourteen to ten inches (Diagram, IIIb), and statistics show a decreasing value year by year in the North Sea taken as a whole, the North Sea being a biologically well-defined area for the "P." *

This being the fact, what can be the reason or the reasons for the declining statistics and for the reduced average size of the "P" in this area? The catching power has been much enlarged, the prices have risen, and the physical conditions have not undergone any unfavourable change; so the decrease in value of the total yearly catch must be ascribed to organic factors, *i.e.* to man or to other organisms.

Has the bottom been injured by trawling in such a way that the food of the "P" has been destroyed?

This view was held in former times, but has never been proved or set forth in such a way as to make it probable. If the "P's" food was destroyed, we might suppose that the "P" in consequence would look very lean, or not be able to grow, as the case is in the Baltic. Marking experiments, nevertheless, prove that the "P" grows fast when not too abundant in a narrow space. Overcrowding may perhaps be found on certain grounds, this being actually the case in the Western Lim Fjord; but in other parts of the Lim Fjord the "P" grows very fast where it is scarce. Experiments of mine specially directed to this point have shown that the small invertebrates are still as numerous per square foot in the western part as in many other places in the Lim Fjord. Speaking generally, we cannot consider that food is wanting in the North Sea, at any rate not to a greater extent than formerly; but in the present state of our knowledge is it possible to suppose that other invertebrates, *e.g.* the star-fish *Asterias rubens*, eat the small bivalves which are the best "P" food, and that *Asterias* is more numerous at the present time because the large "P" individuals have disappeared from many fishing grounds? Investigations on the actual rate of growth of the "P" in such localities may solve this problem—at any rate, they may prove how fast that "P" is growing, which is the essential point in the matter. I do not think it necessary further to discuss it here.

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* I am extremely familiar with this kind of fishing upon the II Group, since the plaice lives in the Lim Fjord, but does not propagate there, perhaps because all plaice are fished out there every autumn when they have grown some few inches during the spring and the summer. The young ones immigrate in numbers every year from the North Sea. In the Lim Fjord we have no true stock at all. What must, then, be thought of the Lim Fjord fishery? Is it "destruction of immature fish," since all are fished out before they reach maturity, and almost entirely fished out every year? The Lim Fjord, however, is not a biologically self-contained area for the plaice, and this question accordingly forms only a part of the whole over-fishing problem. The fjord gets its young plaice from the North Sea every spring, and we in Denmark have only the two things to do: (1) To help into the fjord as many as there is room for, and this is limited, and (2) to leave them in peace during the summer to grow up to a saleable size, like carps in a carp pond. As we get our young plaice every spring for nothing, or almost for nothing, and as they reach a good size for sale during the six to eight months, they ought to be fished out every autumn and winter.

When the "P" grows fast, we might take predatory animals into consideration as a cause of the reduction in the average size of the "P." It will then have to be investigated which predatory animals attack the big "P" more severely than smaller ones. I think it is not very probable that such animals exist. At all events, I do not know of such animals, and have never heard of any.

Other organic factors (diseases) may, perhaps, be mentioned as capable of reducing the average size of the "P." We do not, however, know anything about this; but from our investigations (1) we know the quick rate of growth of the marked "P," and (2) we see that their mortality, except by fishing, is not great in the North Sea. And this is sufficient.

The first immediate influence of fishing is beyond doubt the reduction in number of the "P."* The second influence of fishing is that it prevents the "P" from being as old, and therefore as big, as in places where no fishing is going on. It is in this latter fact, I think, that we have to look for the reduction of the average size of the "P" in the North Sea and in the Kattegat. When admitted that we have not to do with an accumulated stock of "P" in the North Sea, but only with a stock of the II, and a small part of the III Group of "P" highly reduced by fishing and growing up again every year nearly, but not quite, to the same point as the year before, it will be understood that the average size has been slowly reduced year by year. Somebody might already regard this reduction of the average size as over-fishing, yet it is not absolutely so. We suppose that the mature fish, Group III, have been greatly reduced in numbers, but are still capable of yielding sufficient eggs to keep the stock up to date. According to the custom of nature, it is probable that in former times eggs and young fishes were produced in overcrowding multitudes, and that a very high percentage consequently died out. The mature "P" may undoubtedly become so scarce that they cannot supply the stock sufficiently with eggs. If this be so, we have to do with one kind of over-fishing of the mature "P" which reduces the number of "P." I do not, however, suppose this to be the case, but rather that there is a sufficient supply of eggs, and that it is only Group III which has been reduced in average size, and is less numerous than before.

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* It is possible to imagine that reduction of the III Group by fishing may afterwards allow the II Group to spread over a larger area, and consequently procure more favourable conditions for the individuals of this group: (1) they will grow quicker, and (2) the mortality will perhaps be reduced, and the total number of all "P" will thereby in a twelvemonth be larger than before the fishing was carried out. This would be a peculiar result of over-fishing. Whether it really is over-fishing depends upon two things: (1) the amount of reduction of the average size, and the price of the fish at this reduced size; (2) the extent of the increase of the numbers and rate of growth of the II Group. Statistics must solve this problem.

Then there is the possibility that the two other groups, I and II, are growing faster now than before because they have more room, and each of them consequently more food. Group II still consists of saleable fish, and they grow up a year quicker than Group III; not so many of them die or are eaten by animals, because they are only two years old. For these reasons it is very likely that it would pay better to base the fishery for the greater part on this group and not on the III Group.

This problem depends upon the value of the fish in Group II compared with that of the fish in Group III, and upon the mortality in the third year. If we only knew the rate of growth, the mortality during this year, and the price of the fish, the question might be exactly solved by mathematics. In the third year we know that the "P" increases its value four times by growing. If the mortality is as high as one-half during this year, which is not probable, it would pay to prevent all fishing for the II Group. Failure to prevent all fishing for this group would then involve the "destruction of undersized fish." A size limit for the fish would, under these circumstances, be desirable. Studies on the rate of growth, and of predatory animals feeding on the "P," would greatly add to our knowledge on this point.

So far I have dealt with the following three cases:—

I. Over-fishing of an accumulated stock.

II. Over-fishing of the mature fish to so great an extent that they cannot render a sufficient number of eggs to supply the stock with young fishes.

III. Reduction of the average size of the fish to such an extent that they are not sufficiently saleable. This case we may name the "relative destruction of immature fish."

It is, nevertheless, possible to imagine another kind of over-fishing, viz.:—

IV. The Group I of the "P" is living in certain very restricted areas close to the shore where shrimp-trawling is going on. It is possible that shrimp-trawling can destroy too many young ones. This I Group has no value in the market at all, and if such individuals are killed by fishing for shrimps or by other methods, it may, in the true sense of the word, be called "destruction of immature fish."

It is again possible, *e.g.* in the Kattegat, that the stock of "P" is reduced a good deal by fishing, while other allied species, *e.g.* the dab (*Pleuronectes limanda*), are less affected. If this be the case, the last-named fish may then increase its stock and take its food in areas where the "P" was formerly the dominant fish. This only means that the equilibrium of nature has been disturbed by man. We may in many cases expect other organisms to augment the disturbance by retarding the rate of growth of the "P" and by augmenting its mortality, but this has nothing immediately to do with over-fishing.

How is it possible to recognise in nature which of the four kinds of over-fishing we have to deal with in a particular case?

We suppose the "P" to be the most important fish in the North Sea, and the fishing on the whole to be based upon it. We know that the value of the total catch is going down year by year, and that the prices per kilo of the various sizes have been constant or perhaps rising. We know still further that the average size of "P" in the market has gone down. We know the "P" of Group I to be living close to the shore in shallow water, while Group II is living at greater depths, and Group III in the greatest depths of the North Sea. We, furthermore, are acquainted with the facts that no accumulated stock of "P" exists here, that the weight of a II Group "P" on an average is one-quarter kilo, and the price of each fish ten öre (three halfpence), while the "P" of the relatively scarce III Group has a weight of one-half kilo, and the price of it is forty öre (sixpence).

Perhaps we shall never be able to prove in a purely scientific and statistical manner, without experiments by preventive laws, which kind of over-fishing, as set forth in II, III, and IV, actually has damaged the stock of the "P" most seriously in the North Sea—whether over-fishing of the mature III "P," relative destruction of the immature II "P," or the destruction of the I Group. However, we cannot ignore the fact that over-fishing is taking place, and that we must do something if the fisherman is not to starve and the North Sea become a barren "P" fishing ground. What must be done? We must do something that at the same time will help us in all the three kinds of over-fishing. The remedy may be a suitable size limit for saleable "P." If the size limit be sufficiently high, it will, in the markets as well as in the sea, augment the average length of the "P," and, therefore, the number of eggs. It must be high enough to prevent saleable fish of too small a size being admitted to the market. It must further be provided that shrimp-trawling does not destroy too many young "P," as we have perhaps here an essential factor in the problem of over-fishing. In applying this method, all three kinds of over-fishing will be dealt with at the same time.

How to legislate here I do not wish to discuss, nor shall I propose any particular size limit, since the most economical size limit can only be shown by investigations all over the North Sea.

A suitable size limit will be able, in some cases, (1) to augment the average size of the II and especially of the III Groups; (2) to increase the numbers of the III Group, and thereby the number of eggs.

A low size limit may be without any effect at all, while a too high limit may cause an excessive number of "P" to die out or to be eaten before they are fished. I imagine the best size limit will be found in the neighbourhood of the upper part of the II Group, or perhaps in the lowest part of the III Group, since the "P" at this point is growing fast, and increases its value four to five times in one year's growth, and since the "P" at this size obtains the highest price per kilo which on the whole is paid for this species of fish at any size.

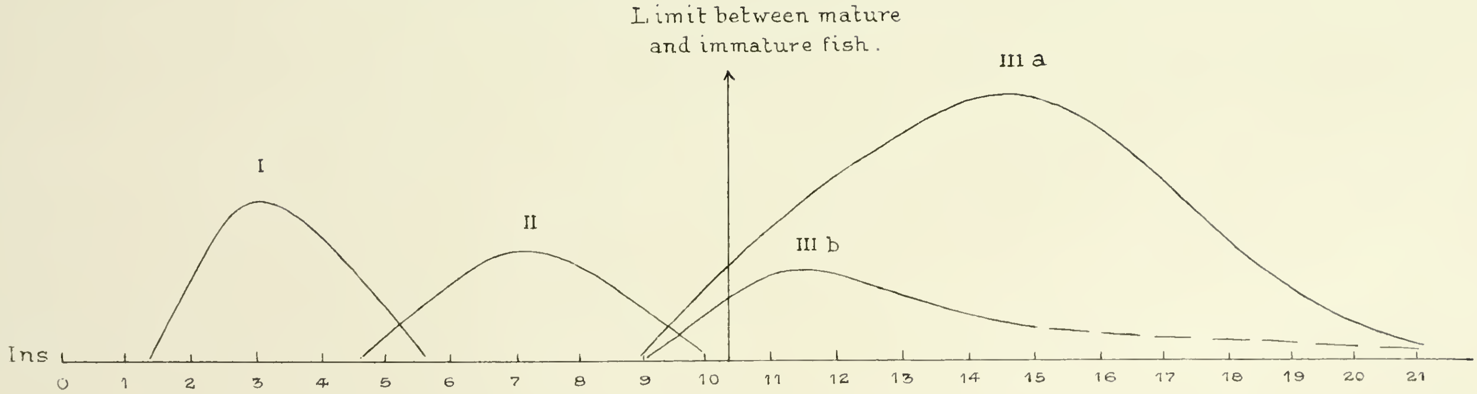
The North Sea is, with regard to the "P," a well-limited area from a biological point of view, but this is not so from all fishermen's points of view. The interests of the shore-fishing vessels are not the same as of the sea-going; and over-fishing is, perhaps, not carried out in all parts of the North Sea, but only in this area taken as a whole. I feel inclined to think that the decrease of the total yearly catch of "P" is essentially due to reduction of the III Group, and, consequently, that the process of over-fishing takes place in the areas inhabited by the fishes of this group, viz. in the open sea. If the shore-fishing vessels do not affect the yield of the large open areas in the North Sea by killing the young "P" on the shore, they should still be left in peace; but if they are now interfering with greater interests, it may be necessary that they, at least to some degree, should give way to the interests of the commonwealth.

It has been proposed by means of artificial hatching, and by artificial fertilisation of eggs, to increase the stock of "P." At present we know, however, that this remedy can only meet one kind of over-fishing. It has also been suggested to fix a size limit simply from a biological point of view, viz. one which should allow fish to spawn once before being caught. This also does not deal with more than one part of the problem; but we have to consider all parts of the problem at the same time as far as we are able. Which of these parts is the most essential can only be ascertained through experience. Artificial hatching would, *e.g.* probably in the Lim Fjord, be of no consequence because the water is so dirty. I also consider all natural hatching here impossible for the "P." In this place a new stock of "P" can only be produced every year by immigration from the North Sea. We know, however, that this immigration does not reach all parts of the fjord to the extent that is desirable, so we help it artificially by transplanting. Such transplantation would, I think, also be useful in larger seas, *e.g.* in the North Sea. It would be a profit to the whole stock if multitudes of small "P" were taken from the overcrowded shallow grounds where they are slowly growing, and transplanted to areas where the III "P" is fished out, and where there is, consequently, enough room and food, —just as young cabbages are planted out every spring. I, for my part, have much more belief in such work than in artificial hatching. By marking the transplanted "P," it is possible to get an idea about their growth, mortality, and augmented value, while we do not know what becomes of the newly-hatched young larval fishes when liberated in the sea.

It has been set forth in former years that "the question of immature fish" was itself an immature question. This charge may have been a just one. Possibly the question when first urged was an immature one; but in a few more years we may hope that the fishes, as well as the questions, will approach maturity more and more, *i.e.* if the fishes are not caught too soon and the questions not forgotten. It is my wish that the question, What is over-fishing? should not be forgotten, but discussed and investigated in every possible way.

Postscript.—To prevent misunderstanding, Dr. Petersen wishes to repeat here that the diagram is not intended to represent the stock of *plaice*, but the stock of a hypothetical species of fish approaching the plaice in habits and conditions of existence. A small number of "annual groups" has been purposely assigned to the hypothetical fish, in order to facilitate simplicity of treatment of the general problem.

Diagram representing the stock of "P" in the North Sea in spring.



Group I. = the one-year-old "P," from c. 1–6 ins.
,, II. = the two-year-old "P," from c. 4–10 ins.
,, IIIa. = the original stock of all "P" three years old and upwards.
,, IIIb. = the reduced stock of the same (for the most part only three years old).

The Larvæ of Certain British Crangonidæ.

By

Robert Gurney, B.A. (Oxon.).

In the present paper I propose to give a brief account of the larvæ of two species of Crangonidæ—*Cheraphilus trispinosus* and *Ægeon fasciatus.* I shall not do more than describe the most characteristic features of the larva, as I hope soon to publish a more complete account of the development, with illustrations.*

The larvæ of Decapod Crustacea are a conspicuous feature of the plankton during the greater part of the year, and their identification being usually impossible without their complete metamorphosis being known, it seems to me to be worth while giving, not only a description of the above-mentioned larvæ, but also a diagnostic table for the distinction of all those Crangonid larvæ at present known.

In drawing up the table given I have depended largely on the paper of G. O. Sars,† but I have been able to confirm his description of the larvæ of *Crangon vulgaris, Cheraphilus nanus,* and *Pontophilus spinosus.*

Of our commoner British species there remains only *Ægeon sculptus* to be investigated. I have found no larva in the tow-net collections during the present year not referable to one or other of the species named, and have only seen a single specimen of the adult. Its larva must therefore remain for the present unknown.

The Larva of Cheraphilus trispinosus (Hailstone).

An abundant supply of zoœas was obtained by keeping berried females in the laboratory tank till the hatching of the eggs. Unfortunately it was found impossible to keep the zoœas alive beyond the first moult, and in spite of the commonness of the adult, very few larvæ have been found in the tow-nets.

The first larva varies in length from 1·8 to 2·0 mm., not including

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* [This account has now appeared. See R. Gurney, "Metamorphoses of the Decapod Crustaceans *Ægeon* (*Crangon*) *fasciatus* (Risso) and *Ægeon* (*Crangon*) *trispinosis* (Hailstone)," *Proceed. Zool. Soc.*, London, 1903, vol. ii. p. 24. E. J. A.]

† "Bidrag til Kundskaben om Decapodernes Forvandlinger, III. fam. Crangonidæ." *Arch. f. Mathem. oy Naturvid.*, xiv. (1890).

the length of the rostrum; the average of twenty-five specimens being 1·9 mm. The body is somewhat transparent and of a light greenish yellow colour, with a conspicuous, large chromatophore dorsally in the middle of the thorax. In general form it resembles closely the zoæa of *Cheraphilus nanus*, the thorax being not conspicuously broader than the first segments of the abdomen, which tapers gradually backwards.

The rostrum is short and pointed, but in later stages it is broad at its base and contracted sharply towards the apex, as is the case also in *C. nanus.* The ventral edge of the carapace is smooth though ending in front in a single short spinous prolongation. The abdominal segments are usually quite smooth, but the fifth segment may in some cases have a pair of short lateral spines. The tail plate is of the usual Crangonid type, with seven strong ciliated setæ on either side.

The inner flagellum of the first antenna is closely ciliated as in *C. echinulatus.* In *C. nanus* there are a few minute spines in addition to the cilia. The scale of the second antenna is narrow and elongated, with seven internal setæ and two setæ and a small spine apically. Externally there are two small setæ. The second antenna agrees closely with that of *C. nanus,* but differs from that of *C. echinulatus* in the narrowness of the scale.

The remaining appendages show no very characteristic features. The larva of *C. trispinosus* may be distinguished by its small size, and by the absence of teeth on the lower edge of the carapace and of spines on the third and fourth abdominal segments.

The Larva of Ægeon fasciatus (Risso).

The length of the larva when just hatched varies from 1·8 to 2·05 mm., the average being 2·0 mm. for twenty-four specimens. This measurement is exclusive of the rostrum, which is about ·17 mm. long at this stage. In general form of body the zoæa is not unlike that of *C. trispinosus*, but it is easily distinguishable. The thorax is not much broader than the first abdominal segment, and the carapace is prolonged forward into a long pointed rostrum. In later stages the rostrum is broad at the base and sharply contracted distally. The lower edge of the carapace is arched and without teeth, ending in front in a small blunt process.

The abdomen tapers but little, though the characteristically expanded epimera of the second segment make it appear considerably broader than the others. The third segment has a pair of backwardly directed dorsal spines; the fourth a pair of small knobs on the posterior dorsal edge, while the fifth segment has on either side a long, downwardly-curved blunt process, which in later stages has the form of a long hooked spine. The tail plate is of the usual form. The first antennæ are very long—about two-thirds of the length of the carapace. The inner flagellum is bluntly pointed and ciliated in the first stage. The scale of the second antenna is long and very narrow, with only six internal setæ, two setæ and a spine terminally, and two short external setæ. The palp of the first maxilla is two-jointed. The remaining appendages I will here leave undescribed.

The larva of *Ægeon fasciatus* can be at once distinguished by the length of the antennæ and the spines of the abdominal segments, the two lateral spines of the fifth segment with their terminal hook being very conspicuous, especially in the later stages.

TABLE FOR THE DISCRIMINATION OF SPECIES HITHERTO DESCRIBED.

1.*	Palp of first maxilla one-jointed	2.
	Palp of first maxilla two-jointed	3.
2.	Third abdominal segment with a dorsal spine	*Crangon vulgaris.*
	Third abdominal segment without a dorsal spine	*C. allmanni.*
3.	Abdomen more than twice as long as thorax	4.
	Abdomen less than twice as long as thorax	5.
4.	Telson deeply incised; posterior dorsal margin of abdominal segments smooth	*Pontophilus spinosus.*
	Telson not deeply incised; posterior dorsal margin of abdominal segments with many small spines	*P. norvegicus.*
5.	Telson with more than sixteen spines	6.
	Telson with fourteen to sixteen spines	7.
6.	No dorsal spines on abdominal segments	*Sabinea septemcarinata.*
7.	Spines of fifth abdominal segment long, curved downwards at the end	*Ægeon fasciatus.*
	Spines of fifth abdominal segment short and pointed, or absent	8.
8.	Third abdominal segment with no dorsal spine	*C. trispinosus.*
	Third abdominal segment with two dorsal spines	9.
9.†	Inner flagellum of first antenna with cilia only	*C. echinulatus.*
	Inner flagellum of the first antenna with cilia and small spines	*C. nanus.*

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* The mysis stage of Crangon differs from that of the other genera in having exopodites on the first four thoracic appendages only, instead of on the first five pairs.

† In the first larva only. In later stages the larvæ must be distinguished by size, *e.g.* last stage: *C. echinulatus*, 4·80 mm.; *C. nanus*, 3·30 (Sars).

Report on the Eggs and Larvæ of Teleostean Fishes observed at Plymouth in the Spring of 1902.

By
Frank Balfour Browne, M.A. (Oxon.).

In the following pages I have attempted, at Mr. Garstang's suggestion, to record the results of the examination of tow-net stages of Teleostean fishes, as it seemed important to determine to what extent the record for 1897, published by Holt and Scott (*Journal M. B. A.*, v., N.S., p. 156), was representative of the conditions usually prevailing in the Plymouth district.

The work was begun in February, and the present paper deals with material taken up to the end of April, the collections being made, as a rule, at intervals of two or three days. So far, some interesting differences in the date of the first occurrence of several of the species from what was recorded in 1897 have been observed.

The first egg of *Pleuronectes flesus* was taken this year on February 21st, while in the 1897 record the date of the first capture of this egg was March 30th. It should be noted, however, that Holt and Scott record no observations between March 1st and 30th, so that the difference in date of appearance in this case (as in some others connected with the same period) may be more apparent than real.

P. microcephalus, first taken this year on February 21st, was found in 1897 on January 29th. This species has only occurred occasionally, usually one egg at a time, through the season, and appears to have been as seldom taken in 1897.

There is no record in 1897 of the occurrence of the eggs of *P. limanda*. One was taken this year on April 14th, which produced a larva 2·63 mm. in length, with pale yellow pigment, and a larva was also taken on April 21st 3.08 mm. in length, showing the same colour.

Solea vulgaris has appeared this year two months earlier, and *S. variegata*, of which I have now had two eggs, three months earlier than in 1897.

The eggs of *Ctenolabrus rupestris*, which Holt and Scott first record on April 27th, have only just made their appearance at the time of writing (May 23rd to 25th), and then in large numbers; while *Trachinus vipera*, which in 1897 did not occur until June 9th, is recorded this year on April 9th. I have only had one egg of this species, but I think there can be little doubt as to its identity. It measured 1·43 mm. in diameter, being larger than the extreme limit given by Holt (*Trans. Roy. Dubl. Soc.*, iv. (1891), p. 437), who gives the limits of variation as 1·25–1·37 mm. It had, however, about fifteen pale green oil globules scattered over the yolk, and the embryo and yolk immediately surrounding it was speckled with pigment which appeared dull yellow by reflected light.

No eggs have appeared this year up to the present corresponding with those recorded as *Trigla gurnardus* on March 30th, 1897.

In other respects my record agrees more or less closely with that of Holt and Scott.

I append a table showing the different times of appearance in the two years of the eggs above referred to.

Species.	First occurrence recorded in 1897.	First occurrence recorded in 1902.
Pleuronectes flesus	Mar. 30th	Feb. 21st.
P. microcephalus	Jan. 29th	Feb. 21st.
P. limanda	not recorded	Apr. 14th.
Solea vulgaris	Apr. 22nd	Feb. 27th.
S. variegata	July 27th	Apr. 21st.
Topknot (with larger oil globule)	Feb. 15th	Mar. 3rd.
Topknot (with smaller oil globule)	Mar. 30th	Mar. 15th.
Gadus merlangus	Mar. 30th	Feb. 25th.
Ctenolabrus rupestris	Apr. 27th	(May 23rd.)
Trachinus vipera	June 3rd	Apr. 9th.
Trigla gurnardus	Mar. 30th	not yet recorded.

Careful coloured drawings have been made of many of the eggs and larvæ recorded, and will, I hope, be useful for future reference.

Before discussing some of the more interesting points which have arisen in connection with the work, I wish to thank Mr. Garstang and Dr. Kyle for help and suggestions on many occasions.

Callionymus.

I obtained eggs of *C. lyra* first on February 14th, almost as soon as I commenced to examine the contents of the tow-nets.

The eggs measured varied in diameter between ·78 and ·93 mm.:—

Millimetres.	·78	·79	·80	·82	·83	·84	·85	·86	·87	·88	·89	·90	·91	·92	·93
Number of eggs	1	3	2	5	2	6	2	3	4	7	1	1	2	2	2

Twenty-three larvæ, measured within thirty-six hours of hatching, varied in length between 1·82 and 2·83 mm.

I found most of these larvæ of the type figured by Holt in his paper in the *Trans. Roy. Dubl. Soc.*, iv. (1891), Pl. LI., Fig. 41, but, at least in most cases, black pigment was present in addition to the yellow, as he has since recorded in this Journal (vol. v. (1897), p. 111).

I also hatched five larvæ from these eggs, which seemed to me to be of a different type from that referred to, but I am not prepared at present to give a final opinion.

The Topknots—Zeugopterus and Phrynorhombus.

In his paper in the *M. B. A. Journal*, v. p. 129, Holt, after discussing the facts then known as to the eggs and larvæ of the three British Topknots, concludes that his three Species x., xi. and xii., described in the *Trans. Roy. Dubl. Soc.*, v. (1893), pp. 96, 99, and 101, had been separated on insufficient grounds.

I have had little material upon which to base conclusions, but such as I have had seems to fall conveniently into two series depending upon the size of the oil globule, as will be seen from the following table:—

Millimetres.	·82	·85	·86	·87	·88	·90	·91	·95	·97
Number of eggs.	4	1	1	1	2	5	1	1	1
Size of oil globule.	·13–·15	·14	·12	·12	·12–·125	·13–·14	·14	·18	·14
Larvæ hatched, length in mm.	2·46	—	2·36	2·42	—	3·37 3·1 3·0	3·18	3·39	2·65

Millimetres.	·99	1·02	1·03	1·04	1·05	1·06	1·07	1·09
Number of eggs.	1	6	6	3	2	1	2	1
Size of oil globule.	·175	·175–·19	·18	·19–·21	·18–·185	·195	·18–·185	·18
Larvæ hatched, length in mm.	—	3·57	—	—	2·88	—	—	—

Thus there seems to be a clear separation between eggs having an oil globule varying between ·12 and ·15 and others having an oil globule varying between ·175 and ·21, though the sizes of the eggs themselves give no clear line of demarcation.

The larvæ hatched from the eggs with the oil globule varying between ·12 and ·15 exactly resembled Species F of M'Intosh and Prince (*Trans. Roy. Soc. Edinb.*, xxxv., Pl. XVII., Fig. 4) and Holt's Species xii. (*Trans. Roy. Dubl. Soc.*, v. (1893), Pl. VIII., Figs. 67 and 68). I did not, however, find any specimens which showed an imperforate anus, as in Holt's figure.

Of the larvæ hatched from the eggs showing the larger oil globule (·175 to ·21) I can only find reference to three in my notes, though many more were hatched. Referring to these three, they certainly did not resemble those hatched from the other series of eggs, though it seemed to me that they might have been very well represented by the figures of either of Holt's Species x. or xi. (*loc. cit.*, Pl. II., Figs. 19–21, Pl. VIII., Fig. 64), according as the light through the microscope was manipulated.

The eggs with the larger oil globule appeared in the tow-nets nearly a fortnight earlier than those with the smaller, the actual dates of their first occurrence being March 3rd for the former and March 15th for the latter. However, on March 7th a female *Zeugopterus norvegicus* was dredged up from which eggs were obtained by slight pressure. These eggs appeared to be ripe, and floated in the sea-water, and were quite translucent. Those measured varied between ·85 and ·90 mm. and the oil globule between ·13 and ·14 mm.

My facts are perhaps too few to permit a definite conclusion, but at least they suggest that the eggs with the smaller oil globule (Mr. Holt's Species xii.) are distinct from those with the larger globule (Mr. Holt's Species x. and xi.), and that the former eggs belong to the smallest topknot, *Z. norvegicus.*

Gadus.

The descriptions given by the various authors of the eggs of the different species of the genus are up to the present insufficient for separating those of several of the commoner kinds, such as *G. luscus, minutus.* and *pollachius.* and possibly also some of those of *G. merlangus.*

In the first place certain eggs varying in diameter between 1·2 and 1·28 mm. seemed to separate out clearly as those of **G. merlangus.** Yellow pigment became early visible in the developing embryo, and the larvæ when hatched showed conspicuous yellow chromatophores all over the head, body, yolk sac, and dorsal and ventral fins. These eggs I have referred to in the record as those of *G. merlangus.* Twenty-two larvæ from these eggs were measured within thirty-six hours of hatching, and their length varied between 3·24 and 3·98 mm., the commonest length being about 3·65 mm.

About 115 **other Gadus eggs** were obtained, those measured varying in size between ·90 and 1·19 mm., as follows:—

Size in millimetres.	·90	·93	·94	·95	·96	·97	·98	·99	1·0	1·01	1·02	1·03	1·05	1·06
Number of eggs. .	1	3	2	6	1	7	9	3	14	2	4	2	1	1

Size in millimetres.	1·07	1·08	1·09	1·1	1·11	1·12	1·13	1·14	1·16	1·17	1·18	1·19	1·2
Number of eggs. .	2	2	1	3	1	1	3	1	1	2	2	1	2

I hatched many of these eggs, the larvæ varying as follows:—

Size in mm.	·95	·96	·97	·98	·99	1·0	1·01	1·02	1·08	1·09	1·1	1·2
Length of larvæ in millimetres.	3·26	2·3	2·35	3·0	3·07	3·36	3·1	2·87	3·6	3·2	2·7	3.2
	—	—	3·0	3·07	3·12	3·1	—	3·0	3·38	—	3·49	3·15
	—	—	—	3·27	—	3·07	—	3·64	—	—	—	3·5
	—	—	—	2·75	—	3·1	—	—	—	—	—	—
	—	—	—	3·2	—	3·27	—	—	—	—	—	—
	—	—	—	—	—	3·05	—	—	—	—	—	—

These measurements were taken within thirty-six hours of the larva hatching. The total number of larvæ hatched and measured was forty-four, and their sizes varied between 2·3 and 3·76, but in all other cases than those given in the above table the larvæ could not be referred to particular eggs.

In most of the eggs when they reached their final stages a yellowish tinge was distinctly visible, and in some cases faint yellow pigment spots could be seen, and in *all* the larvæ produced either a yellowish tinge could be detected or yellow spots were visible just as in the larvæ hatched from eggs attributed to *G. merlangus*, but very faint. The degree of yellowness, however, was not the same in all cases, and in some the pigment spots only became visible when the larvæ were moribund, where before there had only been a faint yellow tinge. In these cases the spots were discernible all along the body and on the head, and in a few cases several spots could be made out on the yolk sac and at the extreme anterior end of the dorsal fin.

With regard to those larvæ which when healthy showed pale pigment dispersed as in *G. merlangus*, I did not have enough to ascertain certainly whether they only arose from the larger eggs. I find one record of an egg 1·09 which produced such a larva 3·2 mm., and I had other such larvæ 3·12, 3·12, 3·12, 3·45, 3·2, 3·2 mm. in length. I kept four of these larvæ on April 12th, hatched from eggs taken on the 9th, and also one larva of *G. merlangus*; and on April 14th the *merlangus* larva still showed strong yellow pigment spots, whereas the other three larvæ (one had died) had lost their distinct chromatophores and only showed a yellow tinge. It is on account of these larvæ that I said that possibly some of the eggs of *G. merlangus* were indistinguishable, and though from the size of the one egg given and from the different appearance of the larvæ they may be some other species than the whiting, there is, of course, nothing at present to draw conclusions from.

Heincke and Ehrenbaum (*Eier und Larven von Fischen der deutschen Bucht*, 1900, pp. 120 and 170) describe the pigmentation of the embryo **pollack** as being similar to that of *G. æglefinus* and possessing black pigment only, arranged in a line down each side to the tail, and they distinguish *G. luscus* from *G. pollachius* by the presence of yellow pigment in the former. Now the pollack is an extremely abundant fish in the neighbourhood of Plymouth, and it would be strange indeed had I not obtained a few eggs at least of this species. Yet the only Gadus egg I have had which showed no trace of yellow was the egg of *G. morrhua*.

Of course, it must be borne in mind that the tow-nets examined have all, or nearly all, been taken within three or four miles of the shore, and in most cases much closer in, so that I may perhaps not have been on the right ground.

Holt (*M. B. A. Journal*, v., p. 141) refers to the eggs of pollack as being 1·4 to 1·45 mm. in diameter and the larva hatched from one of these eggs as being 4·2 mm. in length, and having "a single lateral row of stellate black chromatophores extending from the head to about midway along the tail." I have had no Gadus egg, except that of the cod, so large as those referred to by Holt, and in that case the larva resembled exactly the figure given by Masterman (M'Intosh and Masterman, Plate IX., Fig. 1) for a *G. morrhua*, and also agreed with Holt's description of the larva of that species (*Trans. Roy. Dubl. Soc.*).

Heincke and Ehrenbaum give the limits of size for *G. pollachius* eggs as 1·10 to 1.30 (perhaps 1·45), so that as far as size is concerned many of my eggs could quite well be those of this species. As to the arrangement of pigment in a single row along each side, many of my larvæ showed this when healthy; but when the black pigment spots became very dendritic, after a larva had been on the stage of the microscope for a few minutes, the regularity of the rows was far from obvious, and the pigment spots under these circumstances generally appeared to increase in number. As to the existence of the yellow tinge in my larvæ, I must admit that I was not always sure of its presence immediately the larva was placed under the microscope, but in such cases when it became obvious the larva was not necessarily at the point of death, as I often kept such specimens alive for hours afterwards.

As to the other two species, **G. luscus** and **minutus,** they both occur apparently commonly in the neighbourhood, and from descriptions the larvæ of both show yellow either diffuse or as spots. Holt suggests a later spawning period for the latter species, but I have had no opportunity for investigating this point.

The sizes of eggs taken in February varied between ·98 and 1·09, in March between ·93 and 1·17 (one egg ·90), and in April between ·93 and 1·19.

It was perhaps rather strange finding a single egg of **G. morrhua** on March 15th in the West Channel. The egg was advanced in development, the free caudal portion just appearing. The larva escaped on the 16th or 17th, and on the latter date measured 4·71 mm., the preanal region being 1·83 mm. in length.

The larva exhibited the characteristic barred appearance, and the pigment was arranged precisely as in Masterman's figure referred to above.

As this was the only example I found, and as the egg was already far advanced in development when taken, it had probably drifted a considerable distance from the spawning grounds of the species and evidently out of the usual currents.

Motella.—The Rocklings.

I have had very many eggs which are certainly referable to species of this genus, but they have shown no distinguishable specific characters unless differences in the colour of the oil globules can be considered as such.

From the commencement of the work in February I found eggs with a colourless oil globule common in the tow-nets, and they continued to occur in numbers all through March and the first half of April, after which they gradually became scarcer, until at the end of the month they only appeared now and again.

On March 15th I first obtained a Motella egg with a greenish-yellow globule; and eggs with this character gradually became commoner as those with the colourless one began to diminish, until they took their place as the commonest egg in the tow-nets. These latter eggs were still quite common at the end of April, the point at which the present record ceases.

Only three times did I find eggs with a copper-coloured oil globule. On March 3rd they first appeared in numbers, this date happening to be one on which the egg with a colourless globule was also particularly abundant. I obtained on that date something over one hundred Motella eggs, those with the coloured globule being about equal in number with those having the colourless one.

Though the latter eggs were in all stages of development, none of those with the coloured globule had begun to segment. Of these latter eggs the majority had several small oil globules, many having five, and some even nine.

I reserved a batch of each variety of egg for hatching, placing them in similar vessels containing sea-water. As development proceeded the coloured globules in the one batch gradually became paler, until at the end of three days the colour could, in most cases, only be described as a smoky white. The globules had also generally reduced in number in each egg, one being present in the majority. None of this batch of eggs hatched, although nearly all the batch with colourless globules, about fifteen in number, hatched normally.

On March 11th I again obtained among eggs with the colourless globule a few with the coloured one, and I again endeavoured to hatch them. The colour of the oil globule gradually disappeared as before, but after developing to about the end of Stage II. the eggs again all died.

On March 19th I again obtained a single egg with copper-coloured globule, but it also failed to hatch.

Holt obtained eggs with colourless, "and some few with distinctly cupreous globules," from one specimen of *M. mustela*, so that the colour, not being present in all the eggs, is evidently not characteristic; and from the fact that out of perhaps twenty-five eggs with this distinction I could not get one to hatch it occurred to me that the colour might be indicative of some pathogenic condition. Unfortunately material did not suffice to make further investigations on this point.

The eggs with the green oil globule always developed normally, producing a larva with the same character but otherwise quite similar to larvæ hatched from eggs with the colourless globule. This was as Holt found.

On several occasions I have come across eggs with a large number of colourless oil globules of various sizes, the eggs having a perivitelline space, but never showing any signs of development. The globules in many cases ran together in the course of a few days, but the eggs were infertile. Holt also found these eggs and obtained them directly from a female *Motella mustela.*

On April 9th a ripe female Motella 19 cms. long was brought to me, which proved to be a specimen of *M. fusca* (Moreau), a description of which will be found on another page. Large numbers of eggs had been extruded in the handkerchief in which the fish was carried, and many more were obtained from the fish by slight pressure. These eggs exactly agreed with the infertile eggs above referred to. The size varied between ·69 and ·82 mm. diameter, the majority of those measured, however, being about ·72 to ·74 mm.; and the oil globules, in a few in which only one was present, measured ·13 to ·14 mm.

Brook gives the size of fertilised eggs of *M. mustela* as ·65 to ·73 longer axis, and ·64 to ·716 shorter axis with an oil globule of about ·11. The eggs of *M. fusca*, therefore, appear to be slightly larger, with a larger oil globule than those of the former species, but there is probably not sufficient difference to distinguish between tow-net eggs.

Holt found the size of the eggs with a greenish globule, which he mentions in his Irish papers (*Trans. Roy. Dubl. Soc.*, ii. (1891), p. 464, and v. (1893), p. 95) as ·66, with o.g. ·14, and ·72, o.g. ·17, and I find that those I have obtained this year here vary between ·69 and ·82, o.g.'s ·14 and ·20. The eggs with the colourless globule vary from ·70 to ·87, o.g. ·12 to ·19.

Unless, therefore, the green oil globule can be taken as a specific distinction, there is no evidence at present upon which to identify any of the tow-net eggs with any particular species.

I append tables of the number of eggs at the different sizes which I have obtained, of which I have actual measurement. In many cases I had only recorded that the sizes of a batch obtained varied between two limits, so that these are not included in the tables.

Motella. Table showing number of eggs measured and sizes.

I. EGGS WITH COLOURLESS AND COPPER-COLOURED OIL GLOBULES.

Millimetres.	·70	·71	·72	·73	·74	·75	·76	·77	·78	·79	·80	·81	·82	·83	·86	·87
Number of eggs.	1	1	7	8	5	10	9	12	10	5	9	3	5	3	1	1

II. EGGS WITH GREEN OR GREENISH-YELLOW GLOBULES.

Millimetres.	·69	·70	·71	·72	·73	·74	·75	·76	·78	·80	·82
Number of eggs.	2	3	2	10	6	1	9	3	2	1	1

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Abbreviations employed : sev. = several ; m. = many ; v.m. = very many ; o.g. = oil globule.

For convenience of tabulation the different stages of development have been divided into three groups : Stage I. = if fertilised, stages up to the outgrowth of the eyes ; II. = from I. up to the appearance of the caudal rudiment ; III. = from II. up to hatching.

Since the ova were not always examined immediately after their capture, it was necessary in many cases to compute the stage exhibited at that time. The divisions indicated above being fairly broad, the results set forth below are probably near the mark. Confusion is most liable to have occurred between Stages II. and III. All dimensions are given in millimetres.

Date.	Locality.	Position of Net.	EGGS.					LARVÆ.		
			Species.	No.	Diam. of Egg.	Diam. of Oil Globule.	Stage of Development.	Species.	No.	Length.
					mm.	mm.				mm.
Feb. 6.	2 miles S. of Mewstone.	Surface.	Motella sp.? o.g. colourless.	3	·75–·78	·16	I.	Clupea harengus.	sev.	?
		...	*Clupea sprattus.*	6	1·0–1·1	...	I., III.	C. sprattus.	sev.	?
	...	...	Gadus sp.?	3	1·0–1·05	...	I., II.			
	Cawsand Bay.	Surface.	Eggs not examined.	...	...	...	...	Agonus cataphractus.	1	7·0
,, 11.	4 miles off Rame Head.	Surface, midwater and bottom.	Motella sp.? o.g. colourless.	7	·72–·78	·14–·16	I.	Unrecognisable.	3	
			C. sprattus.	3	1·0	...	I., II.			
,, 12.	½ mile S. of Mewstone.	Surface.	*Pleuronectes platessa.*	1	1·82	...	II.			
,, 14.	4 miles W. of Rame Head.	Surface.	C. sprattus.	sev.	1·0–1·03	...	I., III.	C. harengus.	sev.	?
		Surface.	...	...	...	...	...	C. sprattus.	sev.	?
	...	Midwater.	C. sprattus.	m.	·95–1·1	...	I., III.	Motella sp.?	2	2·6, 2·75
	...	...	Gadus sp.?	4	1·0	...	I.	Species ?	1	2·34
	...	...	*Callionymus lyra.*	2	.80, ·93	...	II., III.	C. harengus.	sev.	?
	...	...	...	...	...	..	...	C. sprattus.	sev.	?
	...	...	...	...	...	...	...	Unrecognisable.	6	
		Bottom.	Callionymus lyra.	4	·85–·90	...	I., II.			
		...	C. sprattus.	m.	1·0–1·03	...	II., III.	Motella ?	1	2·53

Date.	Locality.	Position of Net.	EGGS.					LARVÆ.		
			Species.	No.	Diam. of Egg.	Diam. of Oil Globule.	Stage of Development.	Species.	No.	Length.
					mm.	mm.				
Feb. 19.	1 mile S. of Breakwater Fort.	Surface.	Motella sp.? o.g. colourless.	4	·72–·78	·14–·16	I.			
		Midwater.	Motella sp.? o.g. colourless.	m.	·72–·78	?	I.	Unrecognisable.	2	
	...	...	Gadus sp.?	5	1·0–1·06	...	I., II.			
,, 21.	1 mile S. of Breakwater Light.	Surface.	Clupea sprattus.	sev.	?	...	I., III.	C. harengus.	sev.	?
			Motella sp.? o.g. colourless	sev.	?	?	II., III.	C. sprattus.	sev.	?
	...	Midwater.	C. sprattus.	1	1·0	...	I.	Gadus sp.?	1	5·8
	...	...	Motella sp.? o.g. colourless	3	·72–·75	?	II.	Unidentified.	1	5·5
	...	...	Gadus sp.?	6	·98–1·2	...	II., III.	C. harengus.	sev.	
	...	...	*Pleuronectes microcephalus*	1	1·4	...	I.			
	...	...	*P. flesus.*	1	1·0	...	III.			
	...	Bottom.	Clupea sprattus.	m.	?	...	II., III.			
	...	...	Motella sp.? o.g. colourless.	m.	?	?	I., III.			
	...	...	Gadus sp.?	2	·97, 1·05	...	II., III.			
,, 25.	Off the Shagstone, East Channel.	Surface.	Not examined.							
		Midwater.	*Gadus merlangus.*	1	1·25	...	III.	Unrecognisable.	3	
	...	...	Motella sp.? o.g. colourless.	m.	·72–·76	?	I., II.			
	...	...	C. sprattus.	v.m.	?	...	II., III.			
	...	Bottom.	Not examined.							
,, 27.	West Channel, off Breakwater Light.	Surface.	Clupea sprattus.	sev.	1·05, 1.07, etc.	...	I., III.	C. sprattus.	1	?
		...	Motella sp.? o.g. colourless.	2	·79, ·72	?	III.	C. harengus.	sev.	?
	...	...	Pleuronectesmicrocephalus	1	1·55	...	I.			
	...	...	Callionymus lyra.	1	·92	...	II.			
	...	...	Gadus merlangus.	3	1·25–1·28	...	II., III.			
	...	...	Gadus sp.?	5	·97–1·08	...	II., III.			
	...	Midwater.	Clupea sprattus.	v.m.	?	...	I., III.	Unidentified.	2	3·1, 3·05
	...	...	Motella sp.? o.g. colourless.	v.m.	?	?	II., III.			
	...	..	Gadus merlangus.	7	1·25	...	II., III.			
	...	...	Gadus sp.?	sev.	·98–1·09	...	I., II., III.			
	...	...	Callionymus lyra.	1	·89	...	III.			
	...	...	*Solea vulgaris.*	1	1·48	...	II. or III.			
	...	...	Pl. microcephalus.	1	1·43	...	II.			
	...	...	P. flesus.	2	·99, 1·0	...	II., III.			

Date.	Locality.	Position of Net.	EGGS.					LARVÆ.		
			Species.	No.	Diam. of Egg.	Diam. of Oil Globule.	Stage of Development.	Species.	No.	Length.
					mm.	mm.				
Feb. 27.	West Channel, off Breakwater Light.	Bottom.	Clupea sprattus.	v.m.	?	...	II., III.	Callionymus lyra.	1	1·9
		...	Motella sp.? o.g. colourless.	m.	?	?	II., III.	C. sprattus.	2	?
	...	...	Gadus merlangus.	1	1·25 ?	...	III.	C. harengus.	1	?
	...	...	Gadus sp.?	1	1·0	...	II.			
	...	...	Gadus sp.?	6	?	...	III.			
	...	...	Callionymus lyra.	1	·90	...	III.			
Mar. 3.	West Channel.	Surface.	Motella sp.? o.g. colourless.	v.m.	·72–·78 and others.	·14–·16	I., II., III.			
	...	...	Motella, o.g. copper.	v.m.	·72–·78 and others.	·13–·16 (2 measured).	I.			
	...	...	Gadus merlangus.	1	1·27	...	I.			
	...	...	Gadus sp.?	9	·93–1·02	...	I., II., III.			
	...	Midwater.	Motella sp.? (unfertilised).	3	·82, ·80, ·73	many.	...	Unidentified.	1	5·55
	...	...	Motella sp.? o.g. colourless.	v.m.	·72–·81	?	I., II., III.			
	...	...	Motella sp.? o.g. copper.	v.m.	?	?	I., II., III.			
	...	...	Gadus merlangus.	3	1·25–1·27	...	III.			
	...	...	Gadus sp.?	7	·90–1·15	...	II., III.			
	...	Bottom.	Callionymus lyra.	1	·84	...	III.	C. harengus.	1	?
	...	...	Clupea sprattus.	m.	?	...	II., III.			
	...	...	Motella sp.? o.g. colourless.	m.	·75, ·80, etc.	?	II., III.			
	...	...	Motella sp.? (unfertilised).	1	·74	several.	...			
	...	...	Gadus sp.?	5	·99–1·03	...	II., III.			
	...	...	*Topknot.*	1	1·03	·18	I.			
,, 7.	½ mile S. of Mewstone.	Surface.	Clupea sprattus.	m.	·97–1·05	...	I., III.			
		...	Motella sp.? o.g. colourless.	m.	?	?	I., II., III.			
	...	...	Gadus sp.?	2	·96, ·97	...	I., II.			
	...	Midwater.	Pleuronectes platessa.	1	1·83	...	I.	Cottus bubalis.	1	5·25
	...	...	P. flesus.	1	·98	...	I.	Unrecognisable.	2	
	...	...	Clupea sprattus.	v.m.	·98–1·07	...	II., III.			
	...	...	Callionymus lyra.	1	·93	...	III.			
	...	...	Gadus sp.?	5	·95–1·0	...	I., III.			
	...	...	Motella sp.? o.g. colourless.	5	·77–·83	·13–·15	I., III.			

Date.	Locality.	Position of Net.	EGGS.					LARVÆ.		
			Species.	No.	Diam. of Egg.	Diam. of Oil Globule.	Stage of Development.	Species.	No.	Length.
					mm.	mm.				
Mar. 7.	½ mile S. of Mewstone.	Bottom.	Clupea sprattus.	m.	·97–1·07	...	I., II., III.	Callionymus lyra.	1	2·21
		...	Callionymus lyra.	4	·82–·88	...	I., II., III.	Motella sp.?	2	2·6, 2·9
	...	...	Gadus sp.?	9	·97–1·17	...	I., III.			
,, 10.	West Channel.	Surface.	Nil.							
	...	Midwater.	Motella sp.? o.g. colourless.	3	?	?	I., III.	Motella sp.?	2	?
	...	...	C. sprattus.	11	?	...	I., II., III.	Gadus sp.?	1	2·67
	...	...	...	...	...	...	...	C. sprattus?	1	4·16
	...	Bottom.	Motella sp.? o.g. colourless.	4	?	?	III.	Unidentified.	1	2·5 (?)
,, 11.	West Channel.	Surface.	Motella sp.? o.g. colourless.	6	?	?	I., III.			
	...	...	Motella sp.? o.g. copper.	5	·77–·82	·13–·15	I.			
	...	Midwater.	Motella sp.? o.g. colourless.	sev.	?	?	II., III.	Gobius niger?	1	3·55
	...	...	Motella sp.? o.g. copper.	sev.	?	?	I.			
	...	Bottom.	Motella sp.? o.g. colourless.	sev.	?	?	II., III.	C. sprattus.	2	
	...	...	Motella sp.? o.g. copper.	sev.	?	?	I.			
	...	...	Clupea sprattus.	m.	?	...	I., II.			
,, 15.	West Channel.	Surface.	Gadus merlangus.	7	1·22–1·25	...	II., III.			
	...	...	Gadus sp.?	5	·98–1·06	...	II., III.			
	...	...	Motella sp.? o.g. colourless.	6	·74–·76	?	I., II., III.			
	...	...	Callionymus lyra.	1	·82	...	II. or III.			
	...	...	Pl. microcephalus.	1	1·51	...	II.			
	...	...	P. flesus.	1	·94	...	II.			
	...	...	Solea vulgaris.	1	1·5	...	II.			
	...	...	Topknot.	1	1·07	·18	I.			
	...	Midwater.	Clupea sprattus.	sev.	?	...	I., II., III.			
	...	...	Motella sp.? o.g. colourless.	sev.	·72–·81	?	II., III.			
	...	...	Motella sp.? o.g. green.	1	·76	·14	I.			
	...	...	Gadus merlangus.	18 and more	1·22–1·28	...	I., II., III.			
	...	...	Gadus sp.?	5	1·0–1·18	...	II., III.			
	...	...	*Gadus morrhua.*	1	1·40	...	II. or III.			
	...	...	Callionymus lyra.	6	·87–·88	...	I., II.			

Date.	Locality.	Position of Net.	EGGS.					LARVÆ.		
			Species.	No.	Diam. of Egg.	Diam. of Oil Globule.	Stage of Development.	Species.	No.	Length.
					mm.	mm.				
Mar. 15.	West Channel.	Midwater.	Pl. microcephalus.	4	1·43–1·48	...	I., II., III.			
	...	...	P. flesus.	5	·97–·98	...	I.			
	...	...	Topknot.	3	·95, 1·02, 1·05	·175–·185	I., II., III.			
	...	...	*Topknot.*	6	·90–·91	·14–·15	II., III.			
	...	Bottom.	Not examined.							
,, 19.	1 mile S. of Breakwater Fort.	Surface.	Clupea sprattus.	10 (?)	·93–·98	...	I.			
		...	Motella sp.? o.g. colourless.	v.m.	·73–·80	·125–·165	I., III.			
	...	...	Motella sp.? o.g. copper.	1	·76	·14	I.			
	...	...	Gadus sp.?	3	·97, ·98, 1·0	...	I.			
	...	...	Pleuronectes flesus.	1	1·1	...	III.			
	...	...	Topknot.	3	1·02–1·05	·18	I.			
	...	Midwater.	Clupea sprattus.	v.m.	?	...	I., II., III.			
	...	...	Motella sp.? (unfertilised).	1	·81	many o.g's.	...			
	...	...	Topknot.	4	1·03–1·09	·18	I.			
	...	...	Topknot.	1	·97	·14	II. or III.			
	...	...	Pl. microcephalus.	1	1·41	...	I.			
	...	...	Callionymus lyra.	2	·85, ·87	...	III.			
	...	...	Motella sp.? o.g. colourless.	m.	·77	?	I., II., III.			
	...	...	Gadus sp.?	3	·94–1·01	...	II., III.			
	...	Bottom.	Clupea sprattus.	3	?	...	I.			
,, 21.	East Channel.	Surface.	Topknot.	1	1·025	·19	I.	Cottus bubalis.	1	3·7
	...	...	Gadus sp.?	1	·98	...	I.	Clupea sprattus.	1	3·5
	...	...	Motella sp., o.g. colourless.	m.	·72–·83	·12–·16	I., II.	Unrecognisable.	2	
	...	...	Motella sp., o g. green.	2	·76	·14	I.			
	...	Midwater.	Clupea sprattus.	6	·95–·99	...	I., II., III.			
	...	...	Pleuronectes flesus.	2	1·0, ·93	...	I., II.			
	...	...	Topknot.	1	1·04	·21	I.			
	...	...	Motella sp.? o.g. colourless.	25	·75–·81	·13–·15	I., II.			
	...	...	Motella sp.? o.g. green.	3	·72–·78	·13–·14	I.			
	...	Bottom.	Motella sp., o.g. colourless.	9	?	?	I.			
	...	...	Motella sp. (unfertilised).	1	·80	many o.g's.	...			
,, 25.	West Channel.	Surface.	Clupea sprattus.	1	1·0	...	I.			

Date.	Locality.	Position of Net.	EGGS.					LARVÆ.		
			Species.	No.	Diam. of Egg.	Diam. of Oil Globule.	Stage of Development.	Species.	No.	Length.
					mm.	mm.				
Mar. 25.	West Channel.	Surface.	Motella sp. (unfertilised).	1	·75	many o.g's.	...			
	...	...	Motella sp.? o.g. colourless.	5	·72–·83	·14–·17	I.			
	...	Midwater.	Callionymus lyra.	2	·88, ·91	...	II.	Gobius niger ?	3	3·3, 3·07
	...			...	...	...	...	Motella sp.?	1	2·6
	...	Bottom.	Motella sp.? (unfertilised).	1	·775	many o.g's.	...			
	...	...	Motella sp.? o.g. colourless.	6	·71–·82	·13–·17	I.			
	...	...	Motella sp.? o.g. green.	2	·71, ·70	·16, ·175	I.			
	...	...	Gadus sp.?	1	·94	...	I.			
	...	...	Unidentified.	1	1·12	·205	I.			
,, 27.	Cawsand Bay.	Bottom.	Eggs not examined.	...	...	...	...	Agonus cataphractus.	1	13·5
	...	...	...	...	...	...	...	Callionymus lyra.	2	6·2, 6·01
April 2.	½ mile S. of Mewstone.	Bottom.	Eggs not examined.	...	...	...	...	Pl. microcephalus.	1	5·5
		...	...	...	...	...	...	Gobius niger ?	1	6·4
	...	...	...	...	...	...	...	C. sprattus.	3	5·5, 5·7, 5·9
	...	...	...	...	...	...	...	Callionymus lyra.	3	6·17, 6·0, 6·0
,, 9.	1 mile S. of Mewstone.	Surface.	Gadus merlangus.	1	1·20	...	II.			
		...	Gadus sp.?	3	1·07–1·13	...	I.			
	...	...	Motella sp.? o.g. colourless.	1	·78	?	III.			
	...	...	Callionymus lyra.	4	·78–·89	...	I., II., III.			
	...	...	Solea vulgaris.	1	1·33	...	I.			
	...	...	Topknot.	1	·88	·125	III.			
	...	Midwater.	Gadus sp.?	2	1·17 and 1·08	...	II.	Motella sp.?	1	2·92
	...	...	Motella sp.? o.g. colourless.	1	·75	?	III.	Rhombus lævis ?	1	4·41
	...	...	Callionymus lyra.	2	·90, ·87	...	II., III.			
	...	...	Solea vulgaris.	1	1·41	...	I.			
	...	...	Pl. microcephalus.	1	1·39	...	II.			
	...	...	P. flesus.	1	·93	...	III.			
	...	...	Topknot.	1	1·04	·19	III.			
	...	...	*Trachinus vipera.*	1	1·43	several pale green o.g's.	II.			
	...	Bottom.	Solea vulgaris.	1	1·35	...	I., II.			

Date.	Locality.	Position of Net.	EGGS.					LARVÆ.		
			Species.	No.	Diam. of Egg.	Diam. of Oil Globule.	Stage of Development.	Species.	No.	Length.
					mm.	mm.				
April 9.	1 mile S. of Mewstone.	Bottom.	Pl. microcephalus.	1	1.3	...	I.			
		...	Clupea sprattus.	1	?	...	III.			
	...	...	Callionymus lyra.	3	?	...	II., III.			
	...	...	Gadus sp.?	3	1·03–1·135	...	I., II.			
	1 mile S. of Breakwater Fort.	Surface.	Gadus sp.?	2	·97, 1·16	...	II., III.			
		...	Motella sp.? o.g. colourless.	4	·70–·82	·13–·16	I., II., III.			
	...	...	Motella sp.? o.g. green.	2	·69	·17	I.			
	...	...	Clupea sprattus.	2	1·0, 1·03	...	II.			
	...	...	Callionymus lyra.	2	·79	...	I.			
	...	...	Pleuronectes flesus.	3	·94, ·95, ·97	...	II., III.			
	...	...	Topknot.	2	·86, ·88	·12	II., III.			
	...	Midwater.	Clupea sprattus.	1	1·08	...	I.			
	...	...	Callionymus lyra.	2	·83, ·84	...	II.			
	...	...	Topknot.	1	·82	·14	II.			
	...	...	Gadus sp.?	1	1·19	...	II.			
	...	...	Motella sp.? o.g. colourless.	2	·76, ·79	·13	I.			
	...	...	Motella sp.? o.g. green.	2	·73, ·715	·17, ·16	I., II.			
	...	...	Motella sp.? (unfertilised).	1	·75	many o.g's.	...			
	...	Bottom.	Clupea sprattus.	2	1·03, 1·05	...	III.	Gobius niger?	2	3·5, 3·6
	...	...	Callionymus lyra.	1	?	...	III.	Callionymus lyra.	1	3·2
	...	...	Topknot.	2	·82, ·87	·13, ·12	II.			
	...	...	Topknot.	1	·99	·175	II.			
	...	...	Motella sp.? o.g. green.	1	·70	·14	I.			
	...	...	Gadus sp.?	3	·93–·97	...	II.			
	...	...	Gadus merlangus.	1	1·23	...	II.			
,, 14.	1–3 m. S. to W.S.W. of Mewstone.	Surface.	Callionymus lyra.	3	·84–·86	...	I., III.	Clupea harengus.	2	?
		...	Topknot.	1	1·02	·18	I.	Callionymus lyra.	sev.	4·0–4·7
	...	...	Motella sp.? o.g. colourless.	1	·77	·14	I.			
	...	...	Gadus sp.?	2	1·02, 1·14	...	I.			
	...	Midwater.	Gadus sp.?	3	?	...	III.	Callionymus lyra.	sev.	3·7–4·3
	...	...	*Pleuronectes limanda.*	1	·81	...	III.	Clupea harengus.	1	?
	...	...	Callionymus lyra.	4	·83–·86	...	III.	C. sprattus.	2	?
	...	...	...	...	...	.	...	Motella sp.?	1	2·8

Date.	Locality.	Position of Net.	EGGS.					LARVÆ.		
			Species.	No.	Diam. of Egg.	Diam. of Oil Globule.	Stage of Development.	Species.	No.	Length.
					mm.	mm.				
April 14.	1–3 m. S. to W.S.W. of Mewstone.	Bottom.	Gadus sp.?	1	?	...	III.			
		...	Callionymus lyra.	1	·84	...	III.			
,, 17.	Off mouth of Yealm.	Surface.	Motella sp.? o.g. green.	m.	·72–·73	·16–·17	I , II.			
	...	Midwater.	Pl. microcephalus.	1	1·33	...	III.			
	...	...	Callionymus lyra.	4	·82–·92	...	II., III.			
	...	...	Topknot.	1	1·07	·18	I.			
	...	...	Motella sp.? o.g. green.	m.	·72–·75	·16–·17	I.			
	...	...	Gadus sp.?	1	?	...	III.			
	...	Bottom.	Motella sp.? o.g. green.	v.m.	?	?	I., II., III.			
	½ mile S. of Mewstone.	Surface.	Callionymus lyra.	2	·86, ·88	...	II., III.			
		...	Motella sp.? o.g. green.	m.	?	?	II., III.			
	...	Midwater.	Topknot.	1	·90	·13	II.			
	...	...	Pleuronectes flesus.	1	·99	...	II.			
	...	...	Clupea sprattus.	1	1·0	...	I.			
	...	...	Callionymus lyra.	3	·82–·84	...	II. or III.			
	...	...	Motella sp., o.g. colourless.	3	·76–·82	·13–·14	I.			
	...	...	Motella sp., o.g. green.	v.m.	·73–·75	·15–·20	I.			
	...	...	Gadus sp.?	1	1·0	...	I.			
	...	...	Gadus merlangus.	1	1·2	...	III.			
	...	Bottom.	Motella sp.? o.g. green.	m.	?	?	II., III.			
	West Tinker Buoy, outside Breakwater.	Surface.	Motella sp.? o.g. colourless.	4	·73–·80	·13–·17	I., II., III.			
		...	Motella sp.? o.g. green.	7	·70–·82	·14–·18	I.			
		...	Gadus sp.?	1	·98	...	II.			
	...	...	Clupea sprattus.	1	·96	...	II.			
	...	...	Callionymus lyra.	1	·85	...	II.			
	...	...	Topknot.	2	·82, ·85	·15, ·14	II.			
	..	...	Topknot.	1	1·02	·175	I.			
	...	Midwater.	Callionymus lyra.	2	·80, ·88	...	II., III.			
	...	...	Motella sp.? o.g. green.	m.	·73–·75, etc.	·17–·19, etc.	I., II.			
	...	...	Motella sp.? o.g. colourless.	1	·73	·16	II.			
	...	...	Gadus sp.?	2	·95	...	II., III.			
	...	Bottom.	Motella sp.? o.g. colourless.	1	·87	·15	II.	Gobius niger?	1	4·73
	...	...	Callionymus lyra.	1	?	...	III.	Callionymus lyra.	sev.	?

Date.	Locality.	Position of Net.	EGGS.					LARVÆ.		
			Species.	No.	Diam. of Egg.	Diam. of Oil Globule.	Stage of Development.	Species.	No.	Length.
					mm.	mm.				
April21.	West Channel, ½ m. outside Break-water Light.	Contents of surface, midwater, and bottom nets, mixed.	*Solea variegata.* Callionymus lyra. Topknot.	1 2 2	1·44 ·88, ·91 1·02, 1·04	many. ... ·18, ·195	II. II. I., II.	Solea vulgaris. Solea sp.? Callionymus lyra.	1 1 1	5·14 7·4 3 64
	...	...	Topknot.	1	·82	·14	II.	Pleuronectes limanda	1	3·08
	...	...	Motella sp.? o.g. colourless.	7	·75–·86	·12–·19	I., II., III.			
	...	..	Motella sp.? o.g. green.	m.	·72–·78	·16–·18	I., II., III.			
,, 22.	In Channel between Drake's Island & Great Western Docks.	Surface.	Motella sp.? o.g. green.	3	?	?	I., II.	Pl. platessa ?	1	12·0
		...	Motella sp.? o.g. colourless.	1	?	?	I.	Callionymus lyra.	1	1·67
		Midwater.	Motella sp.? o.g. green.	6	?	?	I., II.			
		...	Motella sp.? o.g. colourless.	1	?	?	I.			
	...	...	Callionymus lyra.	1	?	?	III.			
	...	Bottom.	Motella sp.? o.g. green.	5	?	?	I., II.			
	...	...	Motella sp.? o.g. colourless.	4	?	?	I.			
,, 24.	4 miles S.S.W. of Breakwater Light.	Surface.	Motella sp.? o.g. colourless.	1	·80	·15	III.			
		Midwater.	Motella sp.? o.g. green.	sev.	?	?	II., III.	Callionymus lyra.	2	4·82
	3–4 miles S. of Mewstone.	Surface.	...	...	...	...	...	Callionymus lyra.	1	6.5
		Midwater.	Callionymus lyra.	1	·88	...	I.			
	...	Bottom.	...	...	...	...	...	Clupea harengus.	1	?
	...	...	...	...	...	...	...	C. sprattus.	1	?
	...	...	...	...	...	...	...	C. lyra.	2	?
,, 25.	Off the Mewstone.	Surface. Midwater. Bottom.	Motella sp.? o.g. green.	sev.	?	?	II. or III.	Clupea sprattus.	1	20·0
,, 29.	Inner Eddystone Trawling Ground.	...	No eggs.	...	...	...	...	Solea vulgaris.	2	6·5, 4·1
		...	..	...	...	...	...	Callionymus lyra.	sev.	[etc.
	...	...	...	...	...	...	...	Motella sp.?	sev.	5·3, 5·8, 4·7
	...	...	...	...	...	...	...	Gadus sp.?	1	9·5
	...	...	...	...	...	...	...	Arnoglossus sp.?	1	9·5
	...	...	...	...	...	...	...	Solea lascaris ? ?	2	8·3, 10·31

Record of Demersal Eggs.

Date.	Species.	Stage of Development.	Locality.	Situation.
Feb. 8th.	*Cottus bubalis*	Newly laid	Drake's Island	Under stone between tidemarks. One batch of eggs.
„ 24th.	„ „	I., II., III.	„ „	Under stone between tidemarks. Several batches of eggs. Some larvæ hatched during transit to Laboratory.
Mar. 11th.	*Agonus cataphractus*	I.	„ „	Attached under "roots" of Laminaria. One batch of eggs.
„ „	*Cottus bubalis*	I., II., III.	„ „	Common under stones between tidemarks.
Apr. 11th.	*Agonus cataphractus*	I.	Rum Bay	One batch of eggs (?).
„ 23rd.	*Gobius niger*	I., II.	Drake's Island	Attached to a large stone. One large batch of eggs.
„ 24th.	*Gobius pictus*	I., II.	3 miles S. of Mewstone	Attached inside valve of shell of *Pectunculus glycimeris*.

The Cottus eggs could nearly always be easily hatched out, even when obtained in the earliest stages of development, but neither of the two batches of eggs of *Agonus cataphractus* showed any signs of development, though they retained their more or less transparent appearance for weeks. I have only had two larvæ of this species in the tow-nets, one on February 6th (7 mm. long) and the other on March 27th (13·5 mm. long), both taken in Cawsand Bay.

The eggs of *Gobius niger* also failed to hatch. They were attached to a large stone, which had to be broken up before it could be carried to the Laboratory. Possibly the shock to the eggs in breaking the stone caused their death.

The *Gobius pictus* eggs measured about ·80 mm. longer axis and ·63 mm. across the widest part, and the larvæ hatched from these eggs measured about 3·0 mm. in length. In shape, as well as in size, the eggs agreed exactly with those previously referred to this species by Holt and Byrne (*Journ. M. B. A.*, v., p. 336), and there can be little doubt that this identification is correct.

Notes and Memoranda.

By

H. M. Kyle, D.Sc.

(With Plate III.)

Malformation in Tub (*Trigla lucerna*, Bloch).

During the past year (1902) several cases of peculiarly shaped gurnards were reported from Brixham and Plymouth, and three specimens eventually fell into my hands. They are hunchbacked in form, and are so distinct from the common type that in the days of Couch and Parnell they would have been raised to the dignity of a separate species. No records of such malformations in the gurnards—though common enough in fresh-water forms, as perch and trout—have ever been made so far as my knowledge goes, so that a brief description seems advisable.

In essential characters they are really the tub, and only the peculiar longitudinal compression of the vertebræ, with consequent shortening of the total length, and alteration in the proportions of the various parts of the body, mark them off from this species.

The colouration of the body has for the most part disappeared, as it was some time after capture before they were seen and preserved, but the characteristic deep blue of the large pectorals is still conspicuous. The body is smooth, except for the marginal spines at the base of the dorsal fins. These marginal spines are, as usual, twenty-five in number. The fin-ray formulæ are the same as in the ordinary tub.

$$\text{D}, \frac{8}{16\text{–}17}; \ \text{A}, 16\text{–}17; \ \text{P}, (1+8+2)+3; \ \text{V}, \frac{1}{5}; \ \text{C}, 4+9+3.$$

Vert. 11/21; scales on lateral line, 75.

The specimens are thus in all essential respects the *T. lucerna;* their appearance, however, is very different. The body between the head and tail is short and stunted in proportion to the size of the head; it is likewise deeper and thicker. In two of the specimens this appearance extends uniformly from head to tail (Fig. 1), but in the third there is a sudden contraction just behind the abdominal region, which recalls the hog-backed variety of trout.

The total lengths from the snout to the caudal fork are 20·2 cm., 22·2 cm. for the first two, and 22 cm. for the third. The girths, measured across anus, are correspondingly 63 per cent., 65 per cent., and 50 per cent. of the total length. The head, measured along the side from the spines on the snout to the posterior margin of the opercular flap, is 35 per cent. in the first two specimens, in the third 29 per cent. of the total length; the ordinary values for this dimension are 25 to 27 per cent. The pectorals are 41 to 44 per cent. of the total length, except in the third specimen, where they are normal—namely, 30 per cent. The ventrals are also of great length.

These dimensions help to display the appearance of the specimens. The head seems large and elongated, almost sunk into the thick and deep anterior region of the body. In proportion to the head, the body ought to be 30 cm. long, whereas it is only 20 to 22 cm. Similarly the pectorals, which, except in the third specimen, extend to the root of the tail, are obviously out of proportion, likewise the ventrals. These alterations in the proportions are due not to any structural deformity, but to the shortness of the vertebræ; these seem compressed together and broad in proportion to their length, and the other parts of the body are compelled to follow suit. The internal organs were well developed, and more especially the air bladder, which was apparently larger than normal. Two of the specimens were males, apparently mature; the third was an immature female.

Halibut (*Hippoglossus vulgaris*, Flem.), or **Pole-Dab** (*Pleuronectes cynoglossus*, Linn.).

Two young pleuronectid post-larvæ were taken in the bottom-net in the Moray Firth in August, 1896, and though there is some doubt as to their identity, it seems advisable to publish a short notice of them. It is so seldom that one naturalist is able to obtain a complete series of the young forms of any fish with pelagic eggs and larvæ, that it requires the co-operation of several to differentiate one form from another. Early stages of both these forms have already been described by other observers, and a description of the present specimens—of a stage undescribed as yet—may aid to their more exact determination and to a fuller knowledge of the young stages of one or other of the species.

The spawning season of the halibut, ascertained from the observation of ripe specimens, seems to be chiefly towards the end of April and beginning of May, so far as Britain is concerned. Unripe specimens, however, have been obtained in June, and at Iceland from June to August seems to be the spawning time.* The pole-dab, again, appears to have a similar spawning period. Cunningham† obtained the ripe eggs on the west coast of Scotland towards the end of June, whilst Holt* obtained them in April and May on the west coast of Ireland; whilst young specimens about 42 mm., obtained on the 19th August, he considers to be four to six months old. The spawning season therefore does not aid to the identification of the present specimens, nor does the place where they were captured. Both species occur in the Moray Firth, the halibut being, if anything, the commoner.

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* *British Marine Food-Fishes*, McIntosh and Masterman.

† *Trans. Roy. Soc. Edinburgh*, vol. xxxii., part i., p. 101.

The eggs of the halibut are very large, and vary, according to different observers, between 3·0 and 4·0 mm. From their large size we should expect the larvæ issuing from them to be also large. On the other hand, the eggs of the pole-dab are comparatively small—1·15 to 1·70 mm., and the length of the vitelligerous larva only 4·0 to 4·6 mm. The latest stage of the larval form of the latter species, described by Holt, was 5·57 mm.; the yolk was absorbed, but the notochord and the marginal fins are still in the embryonic condition (*loc. cit.*, Plate IX., Fig. 75). There is a blank between this stage and the next at 42 mm., when the adult characteristics have already been assumed. On the other hand, only one reputed specimen of a post-larval halibut has up to the present been described, and that by Dr. Petersen.† This specimen was 32 mm. long; the migration of the left eye had hardly begun, and the fin-rays were absent from the pectorals and ventrals. The fin-ray formulæ of the unpaired fins left doubts as to whether the specimen was a young halibut or pole-dab, but the large mouth and depression above the snout led Petersen to class it as the former.

The two specimens taken in the Moray Firth were obtained in the bottom tow-net, in company with post-larval plaice, lemon-dabs, and one topknot. Their lengths (in spirit) are 12 and 14 mm.; metamorphosis has hardly begun; the notochord is bent upwards, though not into its final position. True fin-rays to the number of eighteen have appeared in the caudal fin, but in the marginal fins no true rays could be detected until the specimens had been cleared in xylol and mounted in balsam. The length and narrowness of the caudal region show a very early stage of metamorphosis. Across the abdomen the breadth is 2 mm.; across the caudal region, immediately behind the abdomen, only 1 mm., omitting the fins. The head is 18 per cent. of the extreme length and the mandible is 50 per cent., the eye 25 per cent. of the length of the head. Black pigment is present in the form of stellate chromatophores; any other colour which may have been present has disappeared in the spirit.

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* *Trans. Roy. Soc. Dublin*, vol. v. (Series II.), p. 84.

† "On the Biology of our Flat-Fishes," *Danish Biol. Stat.*, iv., 1893, p. 130, Plate II., Fig. 20. The same specimen was mentioned by Collet and Lilljeborg.

There are two conspicuous black bands across the caudal region, three smaller ones on the lower half of the body only alternating with the other two, and a black patch at the root of the tail. Black chromatophores are scattered over the peritoneum posteriorly, along the ventral interspinous bones, and along the lower margin of the abdomen; a few black spots are present also on the clavicle. On the head, a line of black chromatophores marks off the posterior margin of the large optic lobes; the mandible is also pigmented, but not so deeply, and an irregular double row extends longitudinally along the inner surface of the gill cover. The eyes are of an intense black, and are notched in front (Fig. 2).

The most striking features of the post-larvæ, in addition to their length and relative thinness, are the long head, the projecting snout, with the deep depression over the eyes, the projecting abdomen, and the early stage of metamorphosis. The left eye has not yet begun its migration. Of all the pleuronectid larvæ yet described, it is undoubtedly the latest and largest at this stage. In these striking features they are very like the long-rough dab.* The distribution of pigment is about the same; the large mandible and depression behind the snout are alike in both. They differ, however, from the long-rough dab in having a more elongated body at the stage of metamorphosis mentioned, and in having a greater number of fin-rays in the medium fins. Perfect accuracy was impossible in the counting of the latter, because the embryonic condition still persisted at the anterior and posterior ends, but the numbers were approximately D, 103 to 105; A, 83 to 85. These are beyond the formulæ for the long-rough dab, but are within those for the halibut, as given by Smitt;† they are also within those for the pole-dab (*P. cynoglossus*), and herein lies the difficulty. The latest stage, described by Holt, has a similar distribution of pigment, with the exception of the absence of chromatophores along the ventral aspect; these may, of course, develop later. Holt's specimen was less than 6 mm. in length; but their absence is of some importance, because they are present even in the earliest stage of the long-rough dab, to which the halibut is more nearly allied. In Holt's specimen the notochord is not yet bent up, and the other post-larval characteristics have not appeared. As regards form, internal structure, and structure of the head, these species are too closely allied to show distinctive characteristics at such early stages. The size of the mouth might be thought of as a guide, because the long-rough dab and halibut have a large mouth and the pole-dab a small one, and in this respect the present specimens are more like the former; but in the early stages the pole-dab appears also to have a relatively large mouth, so that altogether personal opinion has too much to do with the question.

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* *Ann. Rep. Scottish Fishery Board*, xvi., for 1897, pp. 235, 236, Figs. 17–26.

† *Scandinavian Fishes*, part i., p. 409.

It must remain unsettled for the present whether the pole-dab between 6 mm. and 12 to 14 mm. develops so slowly as to be but little further advanced on its early condition, and is able also to take on characteristics which are very like those of the young long-rough dab. It is not impossible, because the further out to sea the pleuronectids pass their lives, from larva to adult, the more prolonged is their metamorphosis, and the pole-dab* has been obtained at greater depths than the halibut.†

Zeugopterus punctatus, Bl. (Müller's Topknot).

During February, 1901, a young topknot was obtained in a rock-pool at St. Andrews, and as it showed an interesting stage in the development of the scales, Professor McIntosh kindly asked me to write a short note on it. The total length of the specimen is 36 mm., and greatest breadth without fins 15·5 mm. It is thus not quite so broad, relatively to the length, as in the adult. The head, measured along the side, is more than 30 per cent. of the total length, therefore greater in proportion than it is later. These results are in accord with the now well-known observations that as a fish grows its breadth increases and head diminishes relatively to the length.

The fin-formulæ are—

D, 95; A, 70; V, 6/6; P, 8/10.

It is therefore a little abnormal in the pectoral of the eyed side, having only 8 rays where usually there are 11 to 12. The ventrals are well-developed, and are now joined to the anal. According to Smitt (*Scandinavian Fishes*, p. 456), they are separated from the anal at an earlier stage. The colour and markings on the eyed side are as in adult specimens, the blind side being quite colourless. The lateral line is complete on the former side, but on the latter the arch over the pectoral region is not yet formed. There is no trace of "otocystic spines" on the eyed side, nor on the blind side.

The greatest peculiarity, however, is that the scales are still in an early stage of development. On the blind side, which in the adult has only cycloid scales, none can be detected, and on the eyed side the surface of the body and head seems covered over by numerous small soft papillæ. When a scale is examined under a high power, it is seen that these papillæ are due to a pigmented epidermal fold which covers over the projecting part of the scale. The laminated portion is exceedingly thin and slender, and of the future denticles only the chief ones are present, and those in a rudimentary condition (Fig. 3). The central large spine (frequently double) springs directly from the nucleus, and is longer than the scale itself. At the tip it is bent upwards or outwards, a condition which later gives rise to the roughness of the eyed side of the adult topknot. The spines are, as yet, soft and flexible, and when stained with methylen blue display a central stained core surrounded by a clear unstained marginal portion. The smaller spines are bent downwards or inwards at their tips, as if to keep the scale in position. The posterior portion of the scale has a number of black stellate chromatophores scattered over its external surface.

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* Goode and Bean, *Oceanic Ichthyology*, 1896, p. 434.

† I am indebted to Mr. E. W. L. Holt for the doubt with regard to these specimens. At first I was disposed to regard them definitely as young halibut, but from a drawing sent to him Mr. Holt is inclined to think them the pole-dab.

Phycis blennoïdes, Brunner.

In the *Annales du Musée d'Histoire Naturelle de Marseille,* tome v., p. 126, Holt has doubtfully ascribed certain pelagic eggs, with single oil-globule, to this species. In a previous number of the same journal, tome iv., Marion figured a larva in all respects similar to that of *G. minutus,* save that it was smaller, and ascribed it doubtfully to *Phycis.* More recent research has shown that the eggs described by Holt belong to another species of gadoid, and from observations made at Banyuls during the spring of 1898 I found that Marion's conjecture was in all probability correct. The ripe eggs of *Phycis*, obtained in May, varied from ·80 to ·88 mm. in size, being slightly smaller therefore than those of the poor cod.* There was no oil-globule. During the same month the eggs of this species and of *G. minutus* were taken together in the tow-nets. At first these were all relegated to the latter form, but the constant occurrence of a large number at ·80 mm., as well as the observation of the freshly extruded eggs of *Phycis*, left little doubt that both species were really present.

During the first two or three days of development of the tow-net eggs, there was no trace of pigment on embryo or zona; later, a few black spots appeared along the sides of the body and on the head. On hatching, the larva is from 2 to 2·2 mm., and possesses the usual gadoid characteristics. The figure given by Marion (*loc. cit.*, Plate II., Fig. 16) represents it accurately.

It is curious that *Phycis* should so closely resemble the poor cod rather than the more nearly related species—the hake, rockling, and ling; but the herring and its allies have already afforded examples of widely different types of eggs in neighbouring species.

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* ·906 mm., McIntosh and Masterman, *British Marine Food-Fishes.* 1·0 mm., Raffaele, *Mitt. Zool. Stat. zu Neapel,* 1888.

Echinorhinus spinosus, Blain.

The distribution of the spinous shark seems to be extensive, from the North Cape to the Cape of Good Hope, but it is not a common visitor to the shores of Britain, nor indeed anywhere. Day mentions over twenty records of its appearance, spread over some sixty years, and most of the specimens were obtained on the south coast. Stead (*Jour. M. B. A.*, vol. iv. p. 264) gives a description of a further sample captured in 1895. A female specimen, 7 feet long, and about 5 cwt. in weight, was caught in the beam-trawl off the Eddystone, on the 28th November, 1902.

Hybridism in Marine Fishes.

The possibility of hybrids occurring amongst sea fishes has been displayed by various naturalists, of whom Mr. Thomas Scott may be more particularly mentioned. Whilst working on the *Garland* on the east coast of Scotland some twelve years ago, Scott succeeded in fertilising the eggs of several species by the milt of others. The conditions on board were not favourable to the success of the experiments; the embryos died before hatching. One lot of eggs, however, of brill crossed with the turbot, was sent to the St. Andrews Marine Laboratory,* and the young larvæ hatched out there, and seemed as strong and healthy as normal larvæ reared in aquaria.

The probability that hybrids actually occur in the adult condition is a much more difficult matter to determine. At different times supposed hybrids have been examined, only to be rejected, and but few examples have stood the test of scrutiny. According to Günther, a fish obtained at Bristol, the skin of which is in the national collection, may have been a cross between a shad and a pilchard, and another example in the same collection a cross between the two shads.† A nearer approach to certainty, with respect to the shads, has been attained by Hoek,‡ who has made a statistical investigation of the characters of supposed crosses between the two shads of the Rhine. The characters are intermediate between the two species, and reasoning from this fact, as well as from the possibility of cross-fertilisation whilst the fish are spawning on the same or neighbouring grounds, Hoek is inclined to believe that the forms he describes are in reality hybrids.

In this case the species are nearly allied, and for the most part live in fresh water, where hybridisation had already been shown to occur.

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* W. C. McIntosh, *Ann. Rep. Scottish Fishery Board*, ix., p. 317, Plate XIII.

† Day, *British Fishes*, vol. ii., p. 238.

‡ "Neuere Lachs- und Maifisch-Studien," *Tijd. Nederl. Dierkundige Vereenig.* (2), vol. vi., p. 3, 1899.

Better examples of marine forms are found in the so-called turbot-brill and brill-turbot which Smitt* describes. Such specimens are far from uncommon, and have been mentioned by various naturalists. Holt,† into whose hands several specimens came, carefully reviews their characteristics, and points out, in addition to their intermediate character, that his specimens, though large, were still sexually immature. He was inclined to consider them as hybrids between a male turbot and female brill.

During the past year a few observations have been made on this matter, which seem to call for brief notice here.

On the 25th January, 1902, several thousand eggs of plaice were fertilised by the milt of a flounder, both running, and as only a few died during the first few days, the fertilisation must have been successful. Development proceeded very slowly until the 6th February, when the eggs were transferred to the tanks at the Laboratory. At this time the embryo was half-way round the yolk. Development then became rapid, due to the higher temperature, and many embryos were endeavouring to hatch on the 8th. The great majority died during this process, and the few that managed to escape died within a few hours.

Experiments which were going on in the Laboratory at the same time with another batch of eggs from the same plaice, but fertilised by the milt of a plaice, had no better success, and it may be that there was something wrong either with the eggs originally or in the surrounding conditions. Nevertheless, the phenomena displayed during the development of the hybrids are worthy of record.

The colouring of the embryos generally was that of the plaice; the length of the few larvæ which hatched was from 3·5 to 4 mm., being little more than half that of the ordinary plaice larvæ; the yolk-sac was 2 mm. long, so that, as may be imagined, the tail of the larva was extremely short. This had probably a great deal to do with their inability to break through the egg-capsule. Further, instead of the tail being straight, it was curved round the yolk-sac; in fact, if we imagine a small flounder larva with plaice markings, foisted off on a large plaice yolk-sac, we have the exact appearance of these larvæ. The male element seemed to affect the length of the larva, which in other characteristics followed the female; the blastopore, also, was never completely closed, a round, circular opening on the posterior aspect of the yolk-sac being plainly visible. Consequently, on hatching, the yolk-sac was soon ruptured by the entrance of sea-water.

Only two embryos were exceptions to the above. These did not hatch until three days later—namely, on the 9th February. The

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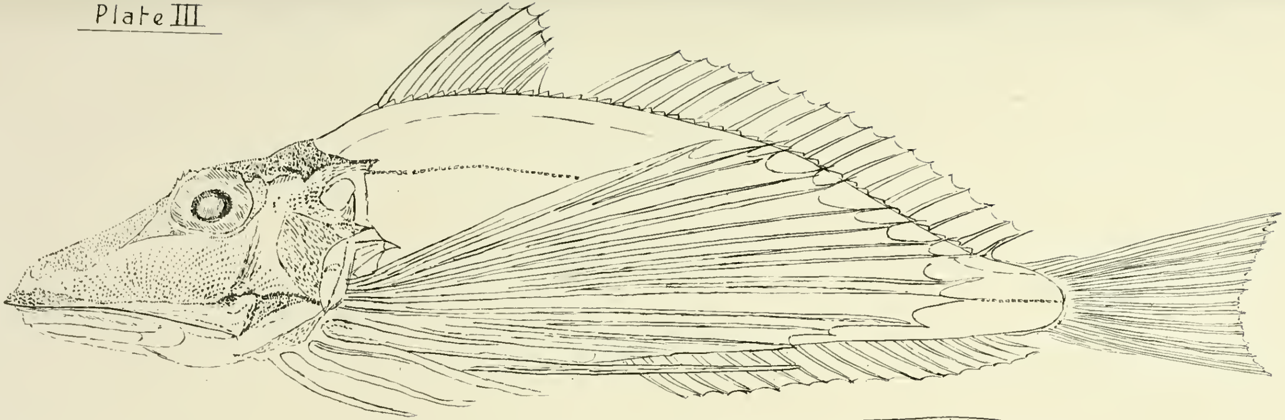
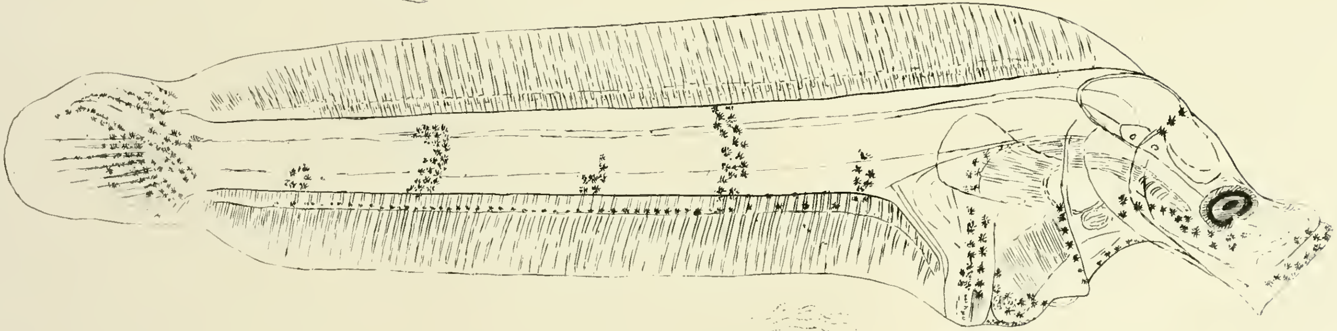
* *Scandinavian Fishes*, vol. i., p. 444.

† *Journ. M. B. A.*, vol. iii., 1895, p. 292.

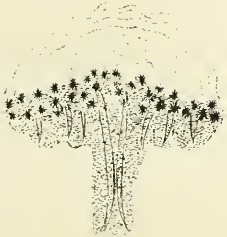
Plate III



1. x 7/8



2. x 12



3. x ca. 150

H. M. K. ad nat delt.

pigment in their case was that of the flounder; the blastopore closed in the usual way, but the short larva was coiled round the yolk-sac in an unnatural manner. The organs of the body were, however, well developed, and the eyes later assumed their black pigment. These larvæ were able to move about in the water but sluggishly, and died within a few hours.

On the 15th February the converse experiment was tried; the ripe eggs of the flounder were fertilised by the milt of the plaice. During the first few days the mortality was very great, but a week later several thousands were still alive and in a healthy condition. The blastopore was completely closed, and the caudal region was beginning to separate off from the yolk; the eyes were formed, and the pigment over the embryo was that of the flounder. A good many died in the later stages within the egg, but a considerable number hatched out and lived for several days, although the water had not been changed for a fortnight. The larvæ which hatched out were a little larger than the ordinary flounder larvæ at that stage, but were in other respects like the flounder. They were strong and active, and did not seem in any way less capable of development than ordinary larvæ reared under similar conditions.

On the 5th March a flat-fish was brought to my notice by some fishermen at Brixham. In their opinion it was a flounder, but they were somewhat puzzled by its smooth appearance and slightly different shape. On examination, it was found that so far as external characters went it was more nearly a plaice. The fin-ray formulæ were too high for the flounder, and the characteristic plaice tubercles were present on the head, whilst the rough spines of the flounder were absent. The only resemblance to the flounder was in its small, closely-set scales and coarse-looking skin, which was much darker than is usual in the plaice, even from deep water. The specimen was 17 inches long and was full of roe. The ripe ova were obtained from it readily, and even to the naked eye appeared much smaller than the normal plaice ova. On examining them under the microscope, they appeared clear and transparent like normal ova. Under a high power the characteristic corrugations of the capsule of plaice eggs were seen. Their size, however, was abnormally small. Of fifty whose dimensions were taken, none exceeded 1·3 mm., and the majority were nearer 1·2 mm. These were representative of the rest in the ovary. The ordinary size of plaice eggs lies between 1·6 and 1·8 mm., so that from this character alone one might infer some mixture of plaice and flounder.

DESCRIPTION OF PLATE III.

Fig. 1.—Abnormal Tub (*T. lucerna.*)

Fig. 2.—Post-larval Pleuronectid (*P. cynoglossus* or *H. vulgaris*).

Fig. 3.—Scale from eyed side of young Topknot (*Z. punctatus*).

Notes and Memoranda.

By

W. Garstang, F. Balfour Browne, and R. Gurney.

Motella fusca. A new British Record. On April 9th Mr. Lowe, Curator of the Municipal Museum, found on the shore under a stone a ripe female Motella, which he brought up to the Laboratory. The fish measured 19 cms. It had three barbels, and on investigation failed to agree with the descriptions of any of the five recognised British species: *M. mustela, tricirrata, macrophthalma, maculata*, or *cimbria*.

The fin-ray formula is:—D, 51 (or 52); P, 17 (or 18); V, 6 (or 7); A, 42; C, 26. The head is broad, with the upper surface flattened, and its length is contained about 5½ times in the total length, being therefore equal to about 18% of the total length. The mouth is relatively small, extending backwards to underneath the eye, the upper jaw being less than half the length of the head and slightly longer than the lower jaw.

The length of the base of the first dorsal fin is slightly longer than the length of the postorbital space, the latter being 92% of the former. The width of the vomers together is greater than the longitudinal diameter of the eye.

The teeth in the upper jaw are, in an outer row, large and somewhat irregular, the others being smaller and more regular. In the lower jaw the outer teeth are small, and there is an irregular row of larger teeth inside.

The colour of the fish is a uniform olive-brown, paler under the body and on the cheeks, the under side of the head being yellowish-white and only slightly pigmented. The fins, now that the fish is preserved, are more or less uniform with the body in colour, but have a slightly bluish tinge.

Our specimen does not agree with the descriptions given by the various authors of any of the three British species which it approaches in its characters: *M. mustela, tricirrata*, or *maculata*.

In its fin-ray formula it corresponds most nearly, except perhaps in its pectoral fins, with *M. mustela*, and also in the smallness of the mouth and general colour it agrees best with this species. The posterior nostrils, which are placed slightly nearer to the anterior ones than to the front edge of the eye, have not however the semicircular flap which protects them in that species, but have an evenly raised margin, as in *M. tricirrata.*

The width of the vomers also, as compared with the longitudinal diameter of the eye, agrees with the description of *M. tricirrata*, and differs from that of *M. mustela* (Smitt, *Scandinavian Fishes*, pt. i. pp. 552, 555). Also bearing in mind the number of barbels present, we may perhaps dismiss *M. mustela* from our speculations.

Our specimen differs from *M. tricirrata*, then, in its fin-ray formula, and it also differs in the length of the base of the first dorsal fin as compared with the length of the postorbital space and in the relative length of the mouth to the head. It differs also from *M. maculata* in its fin-ray formula and in its uniform colour, and also in the entire absence of the black-spotting characteristic of that species, and it agrees very closely with the description of *M. fusca* given by Moreau (*Poissons de la France*, iii. p. 272).

He states that this species is smaller than the others. Our specimen is mature at 19 cms. In *M. fusca* the proportion of length of head to body length, the backward extension of the mouth as compared with the length of the head, the length of the base of the first dorsal fin as compared with the postorbital space, the fin-ray formula and also the colour of the female, correspond exactly with our specimen, which we therefore record as an example of this species.

A description of the ripe unfertilised ova will be found on another page. W. GARSTANG and F. BALFOUR BROWNE.

Monstrilla Helgolandica, ***Claus*****, at Plymouth.**—Two specimens of the species occurred during last year (1902) in the tow-nets at Plymouth. The first was taken in July and the second on September 15th, both being females, the second specimen bearing a number of green eggs nearly ready to hatch. The species has not hitherto been recorded from British seas, the specimens referred to it by Bourne (*Q. J. M. S.*, 1890) being identical with *M. longiremis*, Giesb. The original, very inadequate, description given by Claus (*Freilebenden Copepoden*, 1863) has since been amplified by Timm (*Zool. Anz.*, 1893, and *Wiss. Meeresuntersuchungen*, i. p. 376) from specimens taken near Heligoland. The Plymouth specimens agree in all respects with his description, though it is as well to add that both were abundantly provided with a rich chocolate-coloured pigment. Timm, having only preserved material, speaks doubtfully of the colour.—R. GURNEY.

Report of the Council, 1901–1902.

The Council and Officers.

The four ordinary quarterly meetings of the Council have been held, at which the average attendance has been eight. On each occasion the meeting has taken place at the rooms of the Royal Society, and the Council desires to thank the Royal Society for the accommodation given.

The Council has to record with deep regret the death of Mr. Robert Bayly, one of the Governors of the Association, whose generous support and valued advice and assistance contributed very largely to the successful establishment of the Laboratory at Plymouth.

The Plymouth Laboratory.

The Laboratory continues to be maintained in a state of efficiency, and is well provided with the necessary appliances for marine investigation and biological research. The building, fittings, and machinery are in good order, and the Aquarium is well stocked with fishes and invertebrates.

The Boats.

The steamer *Oithona*, purchased last year, has been constantly and successfully working along the Devonshire coast, and has proved herself a seaworthy and satisfactory ship. She has been fitted with a powerful steam trawling winch, which has greatly increased her usefulness for practical fishery research.

The floating laboratory *Dawn* was this year again placed at the disposal of the Association by Mr. J. W. Woodall, and was stationed during the summer at Exmouth. The addition of the workroom on deck has greatly increased her usefulness.

We have continued to make use of the sailing boat *Anton Dohrn* for work in Plymouth Sound.

The Staff.

Mr. Frank Balfour Browne has been working during the year as an Honorary Assistant to Mr. Garstang for fishery investigations. In other respects there has been no change in the staff, which is now constituted as follows:—Director (Dr. E. J. Allen), Naturalist in charge of Fishery Investigations (Mr. Walter Garstang, assisted as above by Mr. Browne), Fishery Naturalist (Dr. H. M. Kyle, who is appointed in conjunction with the Devon County Council), and Director's Assistant (Mr. R. A. Todd).

Mr. Stuart Thomson, Lecturer on Biology at the Plymouth Technical School, has been engaged in carrying out researches under Mr. Garstang's direction.

Occupation of Tables.

In addition to the names mentioned above, the following naturalists have been engaged in research work at the Plymouth Laboratory during the year:—

W. M. Aders, Ph.D., Marburg (Hydrozoa).
L. Dantan, St. Vaust (Fisheries).
F. W. Gamble, D.Sc., Manchester (Crustacea).
R. Gurney, B.A., Oxford (Crustacea).
Miss Heath, Torquay (General Zoology).
K. Lucas, Cambridge (Tunicata).
G. E. Nichols, Royal College of Science, London (Mollusca).
W. B. Randles, Royal College of Science, London (Mollusca).
H. M. Woodcock, University College, London (Protozoa).

Four students attended a class in Marine Biology held by Dr. Gamble during the Easter vacation, and Mr. M. D. Hill sent his assistant to the Laboratory to collect material for research work.

The Library.

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the year:—

Transactions and Proceedings of the Royal Society of London.
Royal Society. Reports of the Malaria Committee.
Royal Society. Reports of the Evolution Committee.
Transactions and Proceedings of the Zoological Society of London.
Report of the British Association for the Advancement of Science. (Glasgow, 1901.)
Journal of the Royal Microscopical Society.
Quarterly Journal of Microscopical Science. (Presented by Prof. E. Ray Lankester, F.R.S.)
Report of H.M. Inspectors of Fisheries. (England and Wales.)
Report of the Sea and Inland Fisheries of Ireland for 1900.
Return, Sea Fisheries. (Restrictive Legislation in Foreign Countries.)

Report of the Inter-Departmental Committee appointed to inquire into the System of Collecting Fishery Statistics.
Eleventh Annual Meeting of Representatives of Authorities under the Sea Fisheries Regulation Act, 1888.
Report of the Limnological Commission.
Tests and Certificates of the National Physical Laboratory. (Observatory Dept.)
Catalogue of the Radcliffe Library, Oxford.
Cambridge Natural History. (Amphibia and Reptiles.)
Proceedings and Transactions of the Royal Irish Academy.
Annual Report of the Fishery Board for Scotland.
Proceedings of the Scottish Microscopical Society.
Marine Biological Association of the West of Scotland. Annual Report.
Handbook of the Marine Station, Millport.
Lancashire Sea Fisheries. Memoir.
Lancashire Sea Fisheries Committee. Superintendent's Report.
Lancashire Sea Fisheries Laboratory. Report.
Transactions and Annual Report, Manchester Microscopical Society.
Proceedings and Transactions of the Liverpool Biological Society.
Northumberland Sea Fisheries Committee. Report on Scientific Investigations.
Proceedings of the Bristol Naturalists' Society.
Transactions of the Royal Geological Society of Cornwall.
Rousdon Observatory. Meteorological Observations.
The Fishing Gazette.
Science Gossip.
Annual Reports of the Department of Marine and Fisheries, Canada.
University of Toronto. Studies.
Annals of the South African Museum.
Illustrations of the Zoology of the Royal Indian Marine Survey Ship *Investigator*.
Report on the Administration of the Government Museum and Connemara Public Library.
Memoirs of the Bernice Panahi Bishop Museum.
Proceedings of the Linnæan Society of New South Wales.
Records of the Australian Museum.
Fisheries of New South Wales. Report of the Commissioners of Fisheries for [1900.
Transactions and Proceedings of the New Zealand Institute.
Proceedings of the Royal Society at Victoria.
Fauna Hawaiiensis.
Key to the Birds of the Hawaiian Group.
Bulletin du Museum d'Histoire Naturelle, Paris.
Bulletin Scientifique de la France et de la Belgique.
Mémoires de la Société Zoologique de France. Bulletin de la Société Zoologique de France.
Bulletin de la Marine Marchande.
Congrès International de Pêches Maritimes et Fluviatiles. (Bayonne—Biarritz, 1899.)
Bulletin de la Société Centrale d'Aquiculture et de Pêche.
Mission Océanographique dans le Golfe de Gascogne en Galice et en Portugal.
La Feuille des Jeunes Naturalistes.
Le Mois Scientifique.
Verhandlungen der Naturforschenden Gesellschaft in Basel.
Wissenschaftliche Meeresuntersuchungen. Aus der Biologischen Anstalt auf Helgoland.

Mittheilungen des Deutschen Seefischerei-Vereins.
Allgemeine Fischerei-Zeitung.
Mittheilungen aus dem Naturhistorischen Museum in Hamburg
Laboratoire Ichthyologique de Nikolsk. St. Pétersbourg.
Aus der Fischzuchstanstalt Nikolsk.
Die Cypriniden des Kaukasas.
Bulletin du Laboratoire Biologique de St. Pétersbourg.
Russian Fishery Journal.
Revue Internationale de Pêche et de Pisciculture.
The International Exhibition of Fisheries. St. Petersburg.
Acta Societatis pro Fauna et Flora Fennica.
Bergens Museums Aarbog.
An Account of the Crustacea of Norway. By G. O. Sars. (Bergens Museum.)
Norsk Fiskeritidende.
Norges Fiskerier.
Det Kongelige Norske Videnskabers Selskabs Skrifter.
Aarsberetning vedkommende Norges Fiskerier.
Die Erste Nordmeerfahrt des Norwegischen Fischereidampfers *Michael Sars.*
Meddelande fran Göteborgs Fiskeriforening.
Archiv for Mathematik og Naturvidenskab.
Nyt Magazin for Naturvidenskaberne.
Svensk Fiskeri Tidskrift.
Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger.
Mémoire de l'Académie Royale des Sciences et des Lettres de Danemark.
Bihang till Kongl. Svenska Vetenskaps Akademiens Handlingar.
Selskabet for de Norske Fisheriers Fremme.
Mittheilungen aus der Zoologischen Station zu Neapel.
La Nuova Notarisia.
Verslag van den Staat der Nederlandsche Zee Visscherijen.
Mededeelingen over Visscherij.
Tijdschrift der Nederlandsche Dierkundige Vereeniging.
Het Zoölogisch Station der Nederlandsche Dierkundige Vereeniging. Dr. P. P. C. Hoek.
La Cellule.
Bulletin de la Société Belge de Géologie.
Annales du Musée du Congo.
Revista de Pesca Maritima.
Annaes des Sciencias Naturaes.
Bolletino della Societá di Naturalisti in Napoli.
Bulletin and Report of the United States Commission of Fish and Fisheries.
Manual of Fish Culture. Revised Edition. U.S.F.C.
Bulletin and Memoirs of the Museum of Comparative Zoology at Harvard College.
Bulletin of the United States National Museum.
Annual Report of the Smithsonian Institution.
Bulletin and Annual Report of the American Museum of Natural History.
Annals of the New York Academy of Sciences.
Bulletin of the Illinois State Laboratory.
Publications of the Field Columbian Museum.
Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University.
Johns Hopkins University Circulars.
Proceedings of the Boston Society of Natural History.

Proceedings of the American Philosophical Society.
Transactions of the American Microscopical Society.
Studies from the Zoological Laboratory, University of Nebraska.
The American Journal of Anatomy.
Journal of Applied Microscopy and Laboratory Methods.
Proceedings of the American Society of Microscopists.
Results of the Branner-Agassiz Expedition:
  Molluscs from the Vicinity of Pernambuco. W. H. Dahl.
  New Birds of the Families Tanagridæ and Icteridæ. R. Ridgeway.
Papers from the Harriman Alaska Expedition:
  Hydroids. C. C. Nutting.
  Nemertines. W. R. Coe.
  The Ascidians. W. E. Ritter.
Bulletin of the Buffalo Society of Natural Sciences.
Science Bulletin. The Museum of the Brooklyn Institute of Arts and Sciences.
Bulletin from the Laboratory of Natural History of the State University of Iowa.
Publications of the University of Pennsylvania.
Brown University. Contributions from Anatomical Laboratory.
Bryn Mawr College. Monographs. Reprint Series.
The Wilson Bulletin. Oberlin, Ohio.
Oberlin College, Ohio. Laboratory Directions for the Study of Amphioxus.
Publicaciones de la Universidad de la Plata.
Communicaciones del Museo Nacional de Buenos Aires.
Annales del Museo Nacional de Montevideo.
Revista Chilena de Historia Natural.
Journal of the College of Science, University of Tokyo.
Journal of the Fisheries Society of Japan.
Journal of the Fisheries Bureau. Tokyo, Japan.
Annotationes Zoologicae Japonenses.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library:—

Salmo salar. The Digestive Tract of Kelts. J. K. Barton.
What is an Echinoderm? F. A. Bather.
On *Ilyopsyllus coriaceus* and other Crustacea taken at Alnmouth, Northumberland. G. S. Brady.
On Copepoda and other Crustacea taken in Ireland and on the N.E. Coast of England. G. S. Brady.
On Entomostraca collected in the Solway District and at Seaton Sluice, Northumberland, during the Summer 1894. G. S. Brady.
On the British Species of Entomostraca belonging to Daphnia and other allied Genera. G. S. Brady.
Description of a new Species of Cyclops. G. S. Brady.
On the Nature and Origin of Fresh Water Faunas. G. S. Brady.
Address to the Members of the Tyneside Naturalists' Field Club. G. S. Brady.
On Ostracoda taken amongst the Scilly Isles, and on the Anatomy of *Darwinella Stevensoni*. G. S. Brady and D. Robertson.
On the Distribution of British Ostracoda. G. S. Brady and D. Robertson.
Variation in *Aurelia aurita*. E. T. Browne.

The Movements of the Intestines studied by means of the Röntgen Rays. W. B. Cannon.

The Plankton of the North Sea and Skagerak in 1900. P. T. Cleve.

The Seasonal Distribution of Atlantic Plankton Organisms. P. T. Cleve.

Additional Notes on the Seasonal Distribution of Atlantic Plankton Organisms. P. T. Cleve.

The Physiological Zero and the Index of Development for the Egg of the Common Fowl, *Gallus domesticus*. C. L. Edwards.

Unilateral Coloration with a Bilateral Effect. C. H. Eigenmann and C. Kennedy.

Description of a new Cave Salamander. C. H. Eigenmann.

Annelides Polychètes de la Casamance. P. Fauvel.

Notes bibliographiques sur les Insectes nuisibles aux livres et aux reliures. A. Giard.

Sur un Coléoptère nuisible aux carottes Portegraines. A. Giard.

Sur un Acarien vivant sur les Chenilles d' *Agrotis segetum* Schiff. A. Giard.

Pour l'Histoire de la Mérogonie. A. Giard.

Sur l'Homologie des Thyroïdes Laterales avec l'Epicarde des Tuniciers. A. Giard.

A New Sounding and Ground-Collecting Apparatus. G. Gilson.

Annelides Polychètes de la Mer Rouge. H. C. Gravier.

On some Markings on the Skin of a Dolphin. Dr. S. F. Harmer.

President's Address. Norfolk and Norwich Naturalists' Society. Dr. S. F. Harmer.

Dendrocometes paradoxus: Conjugation. Prof. Hickson and J. H. Wadsworth.

Report on Norwegian Fishery and Marine Investigations. J. Hjort.

Structure of the left Auriculo-Ventricular Valve in Birds. A. Hodgkinson.

Notes on D'Orbigny's Figure of *Onychoteuthis dussumieri*. W. E. Hoyle.

On a New Species of Sepia and other Shells collected by Dr. R. Koettlitz in Somaliland. W. E. Hoyle.

On the Generic Names Octopus, Eledone, and Histiopsis. W. E. Hoyle.

L'Esthòtique dans les Sciences de la Nature. C. Janet.

Notes sur les Fourmis et les Guêpes. C. Janet.

Essai sur la Constitution Morphologique de la Tête de l'Insecta. C. Janet.

Sur les Nerfs Cephaliques, les Corpora Allata et le Tentorium de la Fourme (*Myrmica rubra*). C. Janet.

The Methods and Results of the German Plankton Expedition. J. T. Jenkins.

The Fish Fauna of Japan, with Observations on the Geographical Distribution of Fishes. D. S. Jordan.

Start Bay and One of its Problems. H. M. Kyle.

A Treatise on Zoology. Prof. E. Ray Lankester.

Marine Fish Destroyers. W. C. McIntosh.

Descriptive Guide to the Collection of Corals on view at the South London Art Gallery, Camberwell. J. Morgan.

The Ascidians of the Bermuda Islands. W. G. Van Nam.

On Oceanography of the North Polar Basin. F. Nansen. (Presented by Mr. W. Garstang.)

Studies in Relation to Malaria. The Structure and Biology of *Anopheles maculipennis*. G. H. Nuttall and A. E. Shipley. The Pupa. G. H. Nuttall and A. E. Shipley.

Further Observations upon the Biological Test for Blood. G. H. F. Nuttall.

Papers from the Harriman Alaska Expedition. C. C. Nutting.

The Laboratory Equipment of the Bahama Expedition from the University of Iowa. C. C. Nutting.

The Sea-bottom, its Physical Conditions and its Fauna. C. C. Nutting.

Le Cantonnement de Pêche. A. Odin.

A Collection of the Polychæta from the Falkland Islands Some Notes on the Bipolar Theory of the Distribution of Marine Organisms. Miss E. M. Pratt.
Étude Monographique sur le groupe des Infusoires Tentaculifères. René Sand.
Exosporidium marinum. René Sand.
Nematopoda cylindrica. Nov. gen., Nov. spec. René Sand.
Esquisse de l'Evolution de la Division Nucleaire chez les Etres vivants. René Sand.
On some Parasites found in *Echinus esculentus*. A. E. Shipley.
On a New Species of Bothriocephalus. A. E. Shipley.
The Abysmal Fauna of the Antarctic Region. A. E. Shipley.
O Aquario Vasco da Gama. A. da Sitva.
A Catalogue of Crustacea. Prof. D'Arcy Thompson, C.B.
History of the Fisheries of New South Wales, etc. L. G. Thompson.
Marine Fish Hatcheries of Port Hacking, with five Photographs. Hon. J. H. Want, K.C., M.L.C.
A First Study in Natural Selection in *Clausilia laminata*. W. F. R. Weldon.
Les Caféiers. E. de Wildeman.
Die Ursachen des Aussterbens von *Planaria alpina* in Hundsruckgeborge und von *Polycelis cornuta* in Taunus. W. Voigt.

General Report.

Considerable progress has been made with the preparation and arrangement in permanent form of a detailed record of the distribution of the fauna in the immediate neighbourhood of Plymouth. This record, which embodies the results of work done by various naturalists since the time of the foundation of the Laboratory, has specially occupied the attention of Dr. Allen and his assistant, Mr. Todd, for several years past, and when completed should be a substantial contribution to the problems of local distribution, apart from the assistance afforded to future investigations at the Laboratory.

A Report has been published in the Journal of the Association by Dr. Allen and Mr. Todd on the fauna of the Exe estuary. This report embodies the results of work done during the summer of 1901 on board the floating laboratory *Dawn*, which was stationed at Exmouth, and used as a centre for collecting in the estuary. The comparison of the fauna and physical conditions in the Exe estuary with those found during the previous summer in the Salcombe estuary has proved interesting. The thanks of the Association are due to Mr. J. W. Woodall, who not only placed the *Dawn* at the service of the Association, but also met all expenses connected with her maintenance at Exmouth.

Mr. Garstang has been able to devote some attention to working out the results of the periodic cruises which he made in 1899 and 1900 at the mouth of the English Channel for the purpose of investigating the plankton and physical conditions prevailing at different seasons of the year; but owing in part to illness and in part to the time which he has given, at the request of H.M. Government, to matters relating to the British participation in the scheme of International Investigations recommended by the Christiania Conference, these results are not yet completed.

Trawling experiments in the bays on the South Devon coast, similar to those carried on some years ago by Mr. Stead and Mr. Holt, have been resumed during the present year, our steamer *Oithona* being used for the purpose. The investigations have been carried out by Dr. H. M. Kyle, who has made monthly trawlings at fixed stations in the bays, measuring and recording the most important food-fishes, and examining their food and their condition as to spawning. Work of a similar character has also been extended to the offshore grounds, and an attempt has been made to obtain definite information as to the movements of certain kinds of fish. Over five hundred plaice have been marked in the bays and returned to the sea, and a sufficient number of these have been again captured by the fishermen to demonstrate an outward migration from the bays, when the spawning season is coming on.

Mr. Balfour Browne has been engaged during the year in the study of the eggs and larvæ of food-fishes and in experiments on the rearing of larval fishes.

Mr. Stuart Thomson has continued his work on the scales of fishes as an index of age, and has already published a preliminary note upon the subject in the Journal of the Association. Mr. Thomson finds that in certain fishes the lines of growth are comparatively widely separated from one another, in that portion of the scale formed during the warmer season of the year when the rate of growth is rapid, but much less widely separated in that part built up during the colder season.

Mr. Robert Gurney has continuously occupied his Founder's table at the Laboratory, and has completed a number of valuable observations on the different stages in the larval development of various decapod crustacea.

Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association :—

BROWNE, E. T.—*Variation in* AURELIA AURITA. Biometrika, vol. i., No. 1, p. 90.

MACBRIDE, E. W.—*The Development of* ECHINUS ESCULENTUS. Proc. Roy. Soc., vol. lxix., p. 268.

PUNNETT, R. C.—*On Two New British Nemerteans.* Quart. Journ. Micr. Sci., vol. xliv., 1901, p. 547.

PUNNETT, R. C.—*On the Composition and Variations of the Pelvic Plexus in* ACANTHIAS VULGARIS. Proc. Roy. Soc., vol. lxviii., p. 140 ; vol. lxix., p. 2.

RANDLES, W. B.—*On the Anatomy of Trochus.* Report Brit. Assoc., Glasgow, 1901, p. 377.

Donations and Receipts.

The receipts for the year include the grants from His Majesty's Treasury (£1,000) and the Worshipful Company of Fishmongers (£400), Special Donations from Mr. G. P. Bidder (£200), Mr. T. H. Riches (£100), Mr. J. W. Woodall (£39 3*s.* 10*d.*, the expenses of the *Dawn*), and Mr. W. F. Thomas (£5), Founder's Subscription (Mr. R. Gurney, £100), Composition Fees (£15 15*s.*), Annual Subscriptions (£130), Rent of Tables in the Laboratory (£19), Sale of Specimens and Fish (£296), Admission to the Tank Room (£135).

Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1902–1903 :—

President.

Prof. E. Ray Lankester, LL.D., F.R.S.

Vice-Presidents.

The Duke of Abercorn, K.G., C.B.
The Earl of St. Germans.
The Earl of Morley.
The Earl of Ducie, F.R.S.
Lord Avebury, F.R.S.
Lord Tweedmouth, P.C.
Lord Walsingham, F.R.S.
The Right Hon. A. J. Balfour, M.P., F.R.S.
The Right Hon. Joseph Chamberlain, M.P.
Sir Edward Birkbeck, Bart.
Sir Michael Foster, K.C.B., M.P., F.R.S.
A. C. L. Günther, Esq., F.R.S.
Sir John Murray, F.R.S.
Prof. Alfred Newton, F.R.S.
Rev. Canon Norman, D.C.L., F.R.S.
Sir Henry Thompson, Bart.
Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S.

Members of Council.

G. P. Bidder, Esq.
G. C. Bourne, Esq., F.L.S.
Francis Darwin, Esq., F.R.S.
Prof. J. B. Farmer.
G. Herbert Fowler, Esq.
S. F. Harmer, Esq., F.R.S.
Prof. W. A. Herdman, F.R.S.
Prof. G. B. Howes, F.R.S.
J. J. Lister, Esq., F.R.S.
Prof. E. A. Minchin.
Prof. Charles Stewart, F.R.S.
Prof. D'Arcy W. Thompson, C.B.
R. N. Wolfenden, Esq., M.D.

Hon. Treasurer.

J. A. Travers, Esq.

Hon. Secretary.

E. J. Allen, Esq., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council :—

J. P. Thomasson, Esq.
The Prime Warden of the Fishmongers' Company.
E. L Beckwith, Esq. (Fishmongers' Company).
Prof. Sir J. Burdon Sanderson, Bart., F.R.S. (Oxford University).
A. E. Shipley, Esq. (Cambridge University).
Prof. W. F. R. Weldon, F.R.S. (Brit. Assoc. for Advmt. of Science).

Statement of Receipts and Expenditure for the Year ending 31st May, 1902.

Dr.

	£	s.	d.	£	s.	d.	£	s.	d.
To Balance from last year, being Cash at Bank and in hand, viz. :—									
Plant Repairs and Renewals Fund				200	0	0			
Less Amount overpaid on General Account				132	0	9	67	19	3
,, Current Income :—									
H.M. Treasury				1,000	0	0			
Fishmongers' Company (including half-year's payment of £200 on account of year to 31st May, 1903)				400	0	0			
Annual Subscriptions				130	3	0			
Rent of Tables..................................				19	5	0			
Interest on Investment				18	17	7	1,568	5	7
,, Extraordinary Receipts :—									
Founder's Subscription—									
R. Gurney....................................				100	0	0			
Life Member's Composition Fee—									
Col. G. M. Giles				15	15	0			
Special Donations—									
G. P. Bidder	£200	0	0						
T. H. Riches	100	0	0						
J. W. Woodall	33	18	10						
Sir T. Freake	5	5	0						
W. F. Thomas	5	0	0	344	3	10	459	18	10

Investment held 31st May, 1902, £500 Forth Bridge Railway 4% Guaranteed Stock.

Examined and found correct,

(Signed) Edwin Waterhouse.
Stephen E. Spring-Rice.
G. B. Howes.
George P. Bidder.

June 24th, 1902.

Cr.

	£	s.	d.	£	s.	d.	£	s.	d.
By Current Expenditure :—									
Salaries and Wages—									
Director...				200	0	0			
Naturalist..				250	0	0			
Naturalist's Assistant..........................				100	0	0			
Director's Assistant............................				108	6	8			
Wages				572	10	10	1,230	17	6
Travelling Expenses							31	13	4
Library							69	13	1
Journal, Printing and Illustrating				63	3	3			
Less Sales of Journal				8	2	10	55	0	5
Buildings and Public Tank Room—									
Gas, Water, Coal, etc.				98	0	3			
Stocking Tanks, Feeding, etc.				29	2	11			
Maintenance and Renewals				103	19	8			
Rent of Land, Rates, Taxes, and Insurance				15	5	0			
				246	7	10			
Less Admissions to Tank Room				135	17	3	110	10	7
Laboratory, Boats, and Sundry Expenses—									
Stationery, Office Printing, Postages, etc.				103	19	6			
Glass, Chemicals, and Apparatus.................	£96	1	0						
Less Sales	6	7	11	89	13	1			
Purchase of Specimens				29	19	4			
Maintenance and Renewals of Boats, Nets, Gear, etc.	£581	8	6						
Less Sales	287	10	2	293	18	4			
Coal and Water for Steamer				139	18	8			
Insurance of Steamer (two years) and Boiler				32	15	10			
Boat Hire				10	1	0			
				700	5	9			
Less Sale of Specimens	£216	13	0						
Sale of Fish	80	5	11	296	18	11	403	6	10
							1,901	1	9
By Extraordinary Expenditure—									
Cost of Purchase of and Fixing Steam Winch and Feed Tank on s.s. *Oithona*							158	9	4
By Balance of Cash at Bank and in hand,									
Plant, Repairs, and Renewals Fund, including £25 added during year ...				225	0	0			
Deduct Cost of Steam Winch, etc., as above				158	9	4			
				66	10	8			
Less Amount overpaid on General Account				29	18	1	36	12	7

Report of the Council, 1902–1903.

The Council and Officers.

The work of the Council has this year been considerably augmented in consequence of the fact that a commission has been accepted from H.M. Government to carry out in the southern British area the programme of scientific fishery investigations adopted by the International Conference, which met at Christiania in 1901. In addition to the four ordinary meetings of the Council, three special meetings have been held, these being entirely devoted to the organisation of the international work. The average attendance at the meetings has been nine. The Council have again to thank the Royal Society for allowing all the meetings to be held in their rooms at Burlington House.

The Laboratories.

No changes of importance have been made at the Plymouth Laboratory, where the ordinary routine work has been carried on with but little interruption. The buildings are in a good state of repair, and the Laboratory is maintained in an efficient condition.

In order to carry out the work which is required by the international scheme in the southern part of the North Sea, premises have been rented by the Association close to the fishing harbour at Lowestoft, and have been furnished in a manner suitable for conducting laboratory investigations.

The Boats.

For the North Sea fishery investigations the Council have hired for a period of three years the steam trawler *Huxley*, a vessel 115 feet long and 191 tons gross tonnage. Some difficulty was experienced in obtaining a vessel suitable for the work with the funds provided by Government, but the Council were fortunate in securing the assistance of one of their members, Mr. G. P. Bidder, who himself purchased the

Huxley from her former owners, and let her upon favourable terms to the Association. Accommodation for the naturalists has been fitted up in the old fish-hold of the trawler, and a small laboratory has been built on deck. The *Huxley* commenced work in November last.

The Association's steamer *Oithona*, which works in connection with the Plymouth Laboratory, continued the general collecting and the fishery investigations in the South Devon bays during the summer of 1902. She was, however, laid up for the winter months, as the funds at the disposal of the Association did not allow of her being kept in commission throughout the year.

The old sailing boat *Anton Dohrn*, which has done good service for many years, has been replaced by a new and slightly larger boat, which has been given the same name.

The Staff.

The Staff at present employed by the Council is as follows:—

STATIONED AT PLYMOUTH.

Director. E. J. Allen, D.SC.
Hydrographer (International Investigations). D. Matthews.
Assistant Naturalist for Invertebrates. S. Pace.
Assistant „ „ *Plankton* (International Investigations). L. H. Gough, PH.D.

STATIONED AT LOWESTOFT.

Naturalist in charge of Fishery Investigations. W. Garstang, M.A.
Assistant Naturalist for Fishes (International Investigations). W. Wallace, B.SC.
1*st Assistant Naturalist for Invertebrates* (International Investigations). C. Forster Cooper, B.A.
2*nd* „ „ „ „ R. A. Todd, B.SC.

Dr. H. M. Kyle, who was a member of the Association's Fishery Staff during the greater part of the year, has left in order to take up an appointment as Biological Assistant at the Central Bureau of the International Investigations in Copenhagen.

Occupation of Tables.

In addition to those mentioned above, the following have been engaged in research work at the Laboratory during the year:—

G. C. CHUBB, B.Sc., University College, London (Development of the ovary of Antedon).
Miss R. M. CLARK, Plymouth High School (Polyzoa).
Prof. C. B. DAVENPORT, Chicago (Variation of Mollusca).
L. DONCASTER, B.A., Cambridge (Fertilisation in Echinoderms).
E. G. GARDINER, Boston, Mass. (Rhabdocoels).

G. H. GROSVENOR, Oxford (Mollusca).
R. GURNEY, B.A., Oxford (Development of Crustacea).
Prof. S. J. HICKSON, F.R.S., Owens College (Protozoa).
M. D. HILL, M.A., Eton College (Alcyonium).
G. W. SMITH, Oxford (Tunicata).
Miss I. SOLLAS, Cambridge (Porifera).
J. S. THOMSON, Plymouth Technical School (Scales of Fishes).
W. WALLACE, B.Sc., St. Andrews (Fishes).
H. M. WOODCOCK, B.Sc., University College, London (Sporozoa).

Eleven students attended the Easter Vacation Course in Marine Biology, which was conducted by Mr. L. Doncaster, of King's College, Cambridge.

The Library.

The Library has been entirely re-catalogued by Mr. Pace, the titles of the works being typewritten on cards of standard size (5 × 3 in.).

The thanks of the Association are due for the following books and current numbers of periodicals presented to the Library during the year :—

Transactions and Proceedings of the Royal Society of London.
Royal Society. Reports of the Malaria Committee.
Transactions and Proceedings of the Zoological Society of London.
Zoological Record.
Report of the British Association for the Advancement of Science.
Journal of the Royal Microscopical Society.
Quarterly Journal of Microscopical Science. (Presented by Prof E. Ray Lankester, F.R.S.)
Report of H.M. Inspectors of Fisheries (England and Wales) and Statistical Tables.
Report of the Sea and Inland Fisheries of Ireland for 1900.
Department of Agriculture, Ireland. Proceedings of the Inland Fisheries Conference.
Twelfth Annual Meeting of Representatives of Authorities under the Sea Fisheries Regulation Act, 1888.
Report of the Collections of Natural History made in the Antarctic Regions during the Voyage of the *Southern Cross.* (Presented by the Trustees of the British Museum.)
Royal College of Surgeons Museum. Catalogue of Physiological Series. Vol. II.
The Museums Journal.
Journal of Conchology.
Catalogue of the Radcliffe Library, Oxford.
Proceedings and Transactions of the Royal Irish Academy.
Annual Report of the Fishery Board for Scotland.
Proceedings of the Scottish Microscopical Society.
Marine Biological Association of the West of Scotland. Annual Report.
Lancashire Sea Fisheries Committee. Superintendent's Report.
Lancashire Sea Fisheries Laboratory. Report.
Proceedings and Transactions of the Liverpool Biological Society.
Northumberland Sea Fisheries Committee. Report on Scientific Investigations.

Proceedings of the Bristol Naturalists' Society.
Report of the Bristol Museum and Reference Library.
Hastings and St. Leonards Natural History Society's Report.
Rousdon Observatory. Meteorological Observations.
The Fishing Gazette.
Annual Reports of the Department of Marine and Fisheries, Canada.
University of Toronto. Studies.
Annals of the South African Museum.
Cape of Good Hope. Report of the Marine Biologist. Marine Investigations in South Africa.
Report on the Administration of the Madras Government Museum and Connemara Public Library.
Memoirs of the Bernice Pauahi Bishop Museum.
Proceedings of the Linnæan Society of New South Wales.
Records of the Australian Museum.
Fisheries of New South Wales. Report of the Commissioners of Fisheries for 1901.
Transactions and Proceedings of the New Zealand Institute.
Proceedings of the Royal Society of Victoria.
Government of Egypt Zoological Gardens Report.
Conseil Permanent International pour l'Exploration de la Mer. Bulletin des Résultats acquis pendant les Courses Périodiques.
Nouvelles Archives du Muséum d'Histoire Naturelle. Paris. (Presented by the Director of the Royal Gardens, Kew.)
Bulletin du Museum d'Histoire Naturelle, Paris.
Bulletin Scientifique de la France et de la Belgique.
Bulletin de la Société Zoologique de France.
Bulletin de la Marine Marchande.
Bulletin de la Société Centrale d'Aquiculture et de Pêche.
Travaux de l'Institut de Zoologie de l'Université de Montpellier et de la Station Zoologique de Cette.
La Feuille des Jeunes Naturalistes.
Le Mois Scientifique.
Verhandlungen der Naturforschenden Gesellschaft in Basel.
Bulletin Suisse de Pêche et Pisciculture.
Wissenschaftliche Meeresuntersuchungen. Aus der Biologischen Anstalt auf Helgoland.
Mittheilungen and Abhandlungen des Deutschen Seefischerei-Vereins.
Allgemeine Fischerei-Zeitung.
Mittheilungen aus dem Naturhistorischen Museum in Hamburg.
Laboratoire Ichthyologique de Nikolsk. St. Pétersbourg.
Aus der Fischzuchtanstalt Nikolsk.
Bulletin du Laboratoire Biologique de St. Pétersbourg.
Russian Fishery Journal.
Revue Internationale de Pêche et de Pisciculture.
Acta Societatis pro Fauna et Flora Fennica.
Bergens Museums Aarbog.
An Account of the Crustacea of Norway. By G. O. Sars. (Bergens Museum.)
Norsk Fiskeritidende.
Selskabet for de Norske Fiskeriers Fremme Aarsberetning.
Det Kongelige Norske Videnskabers Selskabs Skrifter.
Aarsberetning vedkommende Norges Fiskerier.
Meddelande fran Göteborgs Fiskeriforening.

Archiv for Mathematik og Naturvidenskab.
Nyt Magazin for Naturvidenskaberne.
Svensk Fiskeri Tidskrift.
Bihang till Kongl. Svenska Vetenskaps Akademiens Handlingar.
Svenska Hydrografisk Biologiska Kommissionens Skrifter.
Nova Acta Regiæ Societatis Scientiarum Upsaliensis.
Oversigt over det Kongelige Danske Videnskabernes Selskabs Fordhandlinger.
Mémoires de l'Académie Royale des Sciences et des Lettres de Danemark.
Report of the Danish Biological Station.
The Danish Ingolf Expedition.
Forelobig Meddelelse fra det Danske Hydrografiske Laboratorium.
Mittheilungen aus der Zoologischen Station zu Neapel.
La Nuova Notarisia.
Verslag van den Staat der Nederlandsche Zee-Visscherijen.
Mededeelingen over Visscherij.
Tijdschrift der Nederlandsche Dierkundige Vereeniging.
La Cellule.
Bulletin de la Société Belge de Géologie.
Annales du Musée du Congo.
Annaes des Sciencias Naturaes.
Bolletino della Societá di Naturalisti in Napoli.
Bulletin and Report of the United States Commission of Fish and Fisheries.
Bulletin and Memoirs of the Museum of Comparative Zoology at Harvard College.
Bulletin of the United States National Museum.
Annual Report of the Smithsonian Institution.
Bulletin and Annual Report of the American Museum of Natural History.
Annals of the New York Academy of Sciences.
University of Pennsylvania. Contributions from the Zoological Laboratory. Contributions from the Botanical Laboratory.
Biological Bulletin of the Marine Biological Laboratory, Woods Holl, Mass.
Bulletin of the Illinois State Laboratory.
Publications of the Field Columbian Museum.
Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University.
Johns Hopkins University Circulars.
Proceedings of the American Philosophical Society.
Transactions of the American Microscopical Society.
Science Bulletin of the Museum of the Brooklyn Institute of Arts and Sciences.
Bulletin from the Laboratories of Natural History of the State University of Iowa.
Bryn Mawr College Monographs. Reprint Series.
The Wilson Bulletin. Oberlin, Ohio.
Oberlin College Laboratory Bulletin.
Tufts College Studies (Scientific Series).
Proceedings of the Miramichi Natural History Association.
Bulletin of the Lloyd Library.
University of California Publications.
Communicaciones del Museo Nacional de Buenos Aires.
Annales del Museo Nacional de Montevideo.
Revista Chilena de Historia Natural.
Journal of the College of Science, University of Tokyo.
Journal of the Fisheries Society of Japan.
Annotationes Zoologicae Japonenses.

To the authors of the Memoirs mentioned below the thanks of the Association are due for separate copies of their works presented to the Library :—

The Anatomy of *Scalibregma inflatum*, Rathke. J. H. Ashworth.

The Anatomy of *Arenicola assimilis*, Ehlers, and of a New Variety of the Species. J. H. Ashworth.

Ueber einige Educte des Pferdegehirns. A. Bethe.

Die Heimkehrfähigkeit der Ameisen und Bienen. A. Bethe.

The Early Development of Lepas. M. A. Bigelow.

Le Caryophysème des Eugléniens. P. A. Dangeard.

Fiskeri og Videnskab. G. M. Dannevig.

Second Report on the Result of Crossing Japanese Waltzing Mice with European Albino Races. A. D. Darbishire.

The Advance of Biology in 1897. C. B. Davenport.

A History of the Development of the Quantitative Study of Variation. C. B. Davenport.

On the Variation of the Shell of *Pecten irradians*, Lamarck, from Long Island. C. B. Davenport.

The Statistical Study of Evolution. C. B. Davenport.

On the Variation of the Statoblasts of *Pectinatella magnifica* from Lake Michigan, at Chicago. C. B. Davenport.

The Hydrography of the Faeroe-Shetland Channel. H. N. Dickson.

On rearing the later stages of Echinoid Larvae. L. Doncaster.

Kritisches und Polemisches. Hans Driesch.

Über ein neues harmonisch-äquipotentielles System, etc. Hans Driesch.

Zwei Beweise für die Autonomie von Lebensvorgängen. Hans Driesch.

Neue Ergänzungen zur Entwickelungsphysiologie der Echinidenkeimes. Hans Driesch.

Studien über das Regulationsvermögen der Organismen. Hans Driesch.

Neue Antworten und neue Fragen der Entwickelungsphysiologie. Hans Driesch.

Morphology of the Madreporaria. J. E. Duerden.

Bunodeopsis globulifera, Verr. J. E. Duerden.

Neuere Untersuchungen über den Hummer. E. Ehrenbaum.

South African Corals of the Genus Flabellum. J. S. Gardiner.

On the Anomalous Snakes in the Collections of the Zoological Institute, Strassburg. L. H. Gough.

Tierleben in einem Taubenschlag in Basel. L. H. Gough.

Henri de Lacaze-Duthiers, 1821–1901. S. F. Harmer.

On the Morphology of the Cheilostomata. S. F. Harmer.

The Future of British Fishery Investigation. W. A. Herdman.

Fertilization. S. J. Hickson.

Obituary Notice of Henri de Lacaze-Duthiers. S. J. Hickson.

Fiskeri og Hval Fangst i det Nordlinge Norge. J. Hjort.

Notes on the Type Specimen of *Loligo eblanae*, Ball. W. E. Hoyle.

The Luminous Organs of *Pterygioteuthis margaritifera*, a Mediterranean Cephalopod. W. E. Hoyle.

Clunio bicolor, Kieff; a marine Chironomid new to the Fauna of Great Britain. A. D. Imms.

On the Origin of Pearls. H. Lyster Jameson.

Various Memoirs by C. Janet.

Colour Physiology of the Higher Crustacea. F. Keeble and F. W. Gamble.

Royal College of Surgeons Catalogue. I. (Presented by the Director of the Royal Gardens, Kew.)

Notes on some Marine Turbellaria from Torres Straits. F. F. Laidlaw.
The Marine Turbellaria of the Maldive and Laccadive Archipelagoes. F. F. Laidlaw.
Typhlorhynchus nanus. F. F. Laidlaw.
L'Éclairage et l'emploi du condensateur dans la micrographie histologique. A. Bolles Lee.
Nouvelles recherches sur le Nebenkern et la régression du fuseau caryocinétique. A. Bolles Lee.
The Development of *Echinus esculentus*, together with some Points in the Development of *E. miliaris* and *E. acutus*. E. W. MacBride.
The Electric Conductivities and Relative Densities of certain Samples of Sea-Water. J. J. Manley.
British Amphipoda. A. M. Norman.
Studies in Relation to Malaria. G. H. F. Nuttall and A. E. Shipley.
Notes on the Dispersal of *Sagartia luciae*, Verrill. G. H. Parker.
Resultaten af den Internationella Undersökningen af Norra Europas Djupa Sjöar och Innanhaf År 1900. O. Pettersson.
Gephyrea of the *Southern Cross* expedition. A. E. Shipley.
On a Collection of Parasites from the Soudan. A. E. Shipley.
On the Nematodes Parasitic in the Earthworm. A. E. Shipley.
A Pot of Basil. A. E. Shipley.
Echinoidea of the Maldive and Laccadive Archipelagoes. A. E. Shipley.
Sipunculoidea of the Maldive and Laccadive Archipelagoes. A. E. Shipley.
South African Crustacea. Part II. T. R. R. Stebbing.
Lynceus and the Lynceidae. T. R. R. Stebbing.
De l'Hermaphrodisme chez les Vertébrés. P. Stephan.
Notes on the Habits of Onuphidae. A. T. Watson.
Contributions to the Natural History of the Pearly Nautilus. A. Willey.
A Study of Variation in the Fiddler Crab. R. M. Yerkes.

General Work at the Plymouth Laboratory.

Work on the detailed record of the distribution of the local fauna has been continued as heretofore. Mr. S. Pace is now associated with Dr. Allen in this investigation, in place of Mr. Todd, who has been transferred to the Lowestoft Laboratory. Special attention is being given to the Polychæta. Several interesting species of this group, new to the British fauna, have been obtained, of which detailed descriptions will shortly be published.

The trawling experiments in the bays on the South Devon coast were continued by Dr. Kyle till October of last year, and a report upon this work has since been prepared.

Mr. Stuart Thomson has made progress with his investigation upon the scales of fishes as an index of age, and has prepared a detailed account of his researches which will shortly be published in the Journal of the Association.

Mr. E. G. Gardiner, of Woods Holl, has spent the winter at the Laboratory engaged on a study of the British Rhabdocoels.

The International Fisheries Investigations.

SECTION I.—NORTH SEA WORK.

A. THE TOTAL PROGRAMME OF INVESTIGATIONS.

THE share of the international programme undertaken by the Association consists of the following parts:—

1. A scientific survey, by means of the s.s. *Huxley*, of the trawling grounds lying between the east coast of England and about 3° 30′ E. longitude.

The survey of the continental grounds, from which the largest supplies of undersized flat-fish are derived, falls to the share of Denmark, Germany, and Holland; but investigations on these grounds by the English boat have already been carried out, and will be continued in future from time to time, so that the fullest possible information may be provided concerning the distribution and sizes of fish in this important region.

On all the North Sea voyages of the s.s. *Huxley* arrangements have been made so that the following points may receive particular attention at each station:—

(i.) The nature of the bottom.
(ii.) The nature and abundance of animal life living on the bottom and serving as food for fish or otherwise.
(iii.) The size and weight of the fishes caught.
(iv.) The food of the more important fishes.
(v.) The condition of the fishes as regards sex, maturity, or spawning.
(vi.) The temperature of the sea at surface and bottom.

All fishes of marketable species which are caught are counted and measured. The weight of the catch is separately determined for each species. The records thus obtained are used for comparing the relative abundance and mass of particular species on different grounds, and the differences in the range of size exhibited by the fish of different areas at different seasons of the year.

2. A simultaneous survey of the regular fisheries on the trawling grounds with the assistance of reliable masters of commercial fishing vessels.

The promises of assistance received by the Association from influential boat owners and fishermen are sufficiently numerous to enable a careful selection to be made of the most reliable and competent men for this work. About fifty sailing trawlers from the southern ports and fifty steam trawlers from the northern ports will be employed during the first year. Whether the number of co-operating fishing boats be increased or not will depend on the results of the present year's experience. The Association, however, cannot too publicly acknowledge the spirit of friendliness and confidence with which their proposals for co-operation have been received both by boat owners and fishermen.

Special books of forms are distributed to the fishermen, who record, after every haul of the trawl, in addition to other details, the geographical position, and the total quantity of each kind of fish caught, the more important species being divided into "large," "medium," and "small."

The fishermen's records do not of course enter into the details which characterise the work of the scientific steamer; but they supplement these more exact observations by providing throughout the year a series of synoptic data as to the general course of the fishing in different parts of the area.

The accuracy of the fishermen's records will be systematically controlled by comparison with the catches of the s.s. *Huxley*, which has been fitted with an otter trawl for work on the grounds visited by the steam trawlers, and with a beam trawl for use on the grounds worked by the Lowestoft and Ramsgate smacks, each trawl being of the same kind and size as those used by the regular fishing boats.

The services of specially chosen shrimp fishermen are also being utilised in various districts in connection with the inshore fisheries.

3. Experiments on migration by the marking and liberation of fishes in large numbers over wide areas.

These experiments are designed to throw light on the following points:—

(*a*) The extent and direction of the seasonal and other migrations of food-fishes at different stages of their growth, and over the entire area, particular attention being paid to the migrations of undersized flat-fish.

(*b*) The percentage of fish on the trawling grounds actually caught by the trawling fleets from one year to another.

The results of these experiments will be compared with the fluctuations of fish on the various grounds shown by the trawling records, in order to determine the extent to which the seasonal and other migrations of fish account for the variation in the supply of fish on different grounds.

The experiments will also show the extent to which the so-called "nurseries" of flat-fish serve as a source of supply for the whole of the North Sea area, or for special parts of it.

The general results will be compared with those to be obtained by a biological study of the local varieties of plaice and soles.

4. Special investigations on the rate of growth, age, fecundity, and racial varieties of the more important fishes, especially flat-fish.

These investigations, or some of them, will be carried out in the Lowestoft Laboratory by the scientific staff from material collected on the trawling voyages of the s.s. *Huxley*. One of the aims of the Laboratory investigations will be to provide the necessary materials for a scientific forecast as to the probable effect on the fisheries of the various measures which have been proposed for protecting undersized fish.

5. Special quantitative investigations at sea (in co-operation with the Dutch and German vessels) concerning the abundance of the floating eggs of the sole, as a means of estimating the numbers of the breeding stock of this species.

6. Special investigations in the markets of the chief fishing ports as to variations in the size and weight of fish landed throughout the year.

These investigations are to provide additional data for converting the official statistics on the weight of fish landed into their equivalents in numbers of fish.

B. WORK AND RESULTS TO DATE.

1. The *Huxley* began her fishing work on the 1st November. Her equipment was not then quite complete, but it was considered desirable to begin operations with the least possible delay in order to make preliminary observations and experiments before the winter.

Up to the middle of June the *Huxley* had completed twelve scientific trawling voyages in the North Sea. Investigations have been made along the western, southern, and eastern slopes of the Dogger Bank; in the deep-water area between the Dogger Bank and Shields; on the Hartlepool, Whitby, and California Grounds; in Bridlington Bay; on the Dowsing, Leman, Botney, and New Zealand Grounds; on the deep-water trawling grounds between the English and Dutch coasts; on the Terschelling and Ameland Grounds; in Heligoland Bay; on the shallow grounds north and south of the Horn Reef; and on the deeper grounds between the Horn Reef and the Dogger Bank.

Over 34,000 fishes have been measured, the majority being flat-fish. The animal life of the bottom has been systematically studied from the point of view of distribution, and the food-contents of about 3,000 fishes have been examined and determined.

In the investigation of the plaice nurseries near the Horn Reef in May, Mr. Garstang was joined on board the *Huxley* by the distinguished superintendent of the Danish investigations, Dr. C. G. Joh. Petersen. Opportunity was thus afforded of repeating investigations on some of the same stations which had been explored by the Danish vessel *Thor* six weeks earlier. The comparison of results revealed certain changes in the distribution of fish in the interval, which were further investigated with definite and interesting results.

2. The system of fishermen's records has been put into execution first of all at the port of Lowestoft, where a limited number of sailing trawlers and of steam trawlers belonging to Messrs. Hewett's fleet have been rendering returns since April last. The fishermen employed have shown great interest in the work, and carried it out very satisfactorily. The numbers of boats engaged will be gradually extended to the numbers mentioned in the programme.

3. Plaice have been marked and liberated in various parts of the area south of the latitude of Bridlington. In November and December last the first experiments were made on the grounds where small flat-fish congregate west of the Borkum Reef, and the results obtained are already of great interest and importance. They indicate that during December and January there was a marked migration southwards and westwards of the small plaice previously congregated on the inshore grounds of the northern and western coasts of Holland, the distances travelled being in many cases quite unprecedented, viz. from one hundred to one hundred and sixty miles in six weeks or two months. Over ten per cent. of the fish liberated have already been recovered. Although it is not proposed to draw conclusions at the present stage of the inquiry, these results already suggest that the supply of flat-fish in the southern part of the North Sea, as far south as the Thames estuary, is maintained to some extent by immigrations of small fish from the "nurseries" off the north coast of Holland.

4. The appointment of the Senior Fishery Assistant at the Lowestoft Laboratory to be Biological Assistant at the Central Bureau in Copenhagen has somewhat retarded the progress of the special investigations, since the time of the Chief Naturalist has been mainly spent in organising the work at sea which has been sketched out above. No time, however, will be lost in developing this branch of the work.

5. The investigation of fish eggs will not be commenced until the next breeding season. During a recent visit of the *Huxley* to Heligoland for this purpose, Drs. Heincke and Ehrenbaum joined Mr. Garstang for a day's fishing, and demonstrated their appliances for this part of the work. Uniform apparatus is now being prepared for next season's investigations.

6. Special assistants are being trained for the work in the markets, but have not yet begun operations away from Lowestoft.

Section II.—HYDROGRAPHIC AND PLANKTON WORK IN THE ENGLISH CHANNEL.

The English portion of the international scheme of hydrographic and plankton observations, the execution of which has been assigned to the Marine Biological Association, is to be carried out in the western half of the English Channel.

These investigations have for their object the study of the seasonal changes which take place in the physical and biological conditions prevailing over the entire region covered by the international programme, though more particularly directed to a study of the waters entering the North Sea from different directions. They are designed to determine (1) the origin, history, and physical and biological characters of the water found in each locality at different seasons of the year and at corresponding seasons in different years, changes in which must necessarily have a profound influence upon the distribution and abundance of the fish-life in the sea, and (2) the variations which take place in the floating and swimming organisms (plankton) which constitute the fundamental food-supply of the sea.

A. METHOD OF INVESTIGATION.

The investigation is being carried out (1) by means of a series of quarterly cruises made simultaneously over the whole area by the vessels of the participating countries, as a result of which a thorough knowledge, based upon the most accurate available methods, is obtained of the conditions prevailing at all depths at certain fixed stations, together with a less detailed knowledge at intermediate points; and (2) by observations, more especially of the surface conditions, at as many points as possible during the time intervening between the seasonal cruises.

The particular portion of the work which falls to the lot of the Marine Biological Association may now be described in more detail.

I. Seasonal Cruises.

The seasonal cruises are carried out as nearly as circumstances will allow during the first fortnights of February, May, August, and November, with the view of studying in detail the mid-winter, mid-spring, mid-summer, and mid-autumn conditions.

The following twenty stations in the western half of the English Channel are to be worked on each cruise:—

List of Stations.

I. 10 miles S.W. ¼ S. southerly of the Eddystone.
II. 47 „ „ „ „ „ „ (mid-channel).

III.	8	miles	N. by W. of Ushant.
IV.	55	„	W. by N. of Station III. (Parson's Bank).
V.	40	„	N.N.E. of Station IV. (mid-channel).
VI.	30	„	N. of Wolf Rock (Bristol Channel).
VII.	8	„	S.E. of Wolf Rock (Mount's Bay).
VIII.	95	„	„ „ (mid-channel).
IX.	30	„	N.E. by E. of Station VIII.
X.	9	„	N.E. by N. of Casquets (Hurd's Deep).
XI.	28	„	E.N.E. $\frac{1}{2}$ E. of Station X. (off Cape La Hague).
XII.	14	„	N.E. by N. of Cape Barfleur.
XIII.	25	„	N. $\frac{3}{4}$ E. of Station XII. (mid-channel).
XIV.	2	„	S. $\frac{3}{4}$ W. of St. Catherine's Point.
XV.	10	„	S. by E. of Anvil Point.
XVI.	8	„	S.S.W. of Portland Low Light.
XVII.	30	„	E.S.E. of Start Point (mid-channel).
XVIII.	15	„	N.N.W. of Station XVII. (Great West Bay).
XIX.	20	„	S. by E. of Start Point (mid-channel).
XX.	5	„	S.S.W. of Bolt Head.

(The bearings given are magnetic.)

At each station the following programme of work is carried out:—

1. *Hydrographic and Meteorological.*—The temperature of the water at the surface is taken, and also, by means of the Pettersson-Nansen water-bottle with thermometers graduated to $\frac{1}{10}$° centigrade, the temperatures at 5, 10, 15, 20, 30, 40, 50, 75, 100, 125 metres, and at the bottom.

Samples of water are procured at each of the above depths, and from these samples the salinity is subsequently determined in the laboratory by Volhard's titration method.

Observations of the temperature of the surface water are taken every two hours when running between the stations, and meteorological observations, including readings of the barometer and of the wet and dry bulb thermometer, are made at similar intervals.

2. *Plankton.*—Samples are taken with the following nets at each station:—

(*a*) A vertical haul with a small Hensen net, the silk of which has 150 meshes to the inch.

(*b*) Hauls with the Garstang closing net, fitted with silk having 100 meshes to the inch, at 10 metres, mid-water, and bottom.

(*c*) Surface gatherings with four ordinary tow-nets having silk 26, 50, 100, and 150 meshes per inch respectively.

The eight samples from each station are subsequently examined in the laboratory, all the species of animals and plants they contain being recorded, and the abundance of each indicated according to the system adopted by the International Council.

II. Intermediate Observations.

Arrangements are being made for obtaining frequent observations of surface temperature and samples of surface water and plankton from lightships round the coast, as well as from steamers running along certain routes. These observations will be extended as far to the westward and north-westward as possible.

The regular station work will be carried out as frequently as possible, in the intervals between the seasonal cruises, at one or two stations at the western end of the English Channel.

B. WORK ALREADY ACCOMPLISHED.

All the stations set forth above were worked during the first fortnight of February (1903) with the steamer *Huxley*, and a complete set of observations and samples obtained from each. The salinity of all the water samples has since been determined, and a record of these and of the other observations made has been forwarded to the Central Bureau at Copenhagen for publication in the International Bulletin.

The samples of plankton collected have been qualitatively examined, and the species, more especially of Diatoms, Peridinidae, and Copepoda, determined in all cases. These results will also be forwarded to the Central Bureau for publication.

A similar series of observations was carried out during the first fortnight of May.

Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association:—

MacBride, E. W.—*The Development of* ECHINUS ESCULENTUS, *together with some points in the Development of* E. MILIARIS *and* E. ACUTUS. Phil. Trans. Roy. Soc., London. Series B. vol. cxcv., 1903, pp. 285–327.

Gurney, R.—*The Metamorphosis of* CORYSTES CASSIVELAUNUS (Pennant). Quart. Journ. Micr. Sci., vol. xlvi. pp. 461–478.

Thomson, J. S. *The Scales of Fishes as an Index of Age.* Brit. Assoc. Report, Belfast, 1902.

Woodcock, H. M. *Life-history of* SPOROZOA. Brit. Assoc. Report, Belfast, 1902.

Donations and Receipts.

The receipts for the year for the ordinary work of the Association include the grants from His Majesty's Treasury (£1,000) and the Worshipful Company of Fishmongers (£400), Composition Fees (£15 15*s.*), Annual Subscriptions (£122), Rent of Tables in the Laboratory (£17), Sale of Specimens and Fish (£315), Admission to the Tank Room (£137).

Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1903–1904:—

President.

Prof. E. Ray Lankester, LL.D., F.R.S.

Vice-Presidents.

The Duke of Abercorn, K.G., C.B.
The Earl of St. Germans.
The Earl of Morley.
The Earl of Ducie, F.R.S.
Lord Avebury, F.R.S.
Lord Tweedmouth, P.C.
Lord Walsingham, F.R.S.
The Right Hon. A. J. Balfour, M.P., F.R.S.
The Right Hon. Joseph Chamberlain, M.P.
Sir Edward Birkbeck, Bart.
Sir Michael Foster, K.C.B., M.P., F.R.S.
A. C. L. Günther, Esq., F.R.S.
Sir John Murray, F.R.S.
Prof. Alfred Newton, F.R.S.
Rev. Canon Norman, D.C.L., F.R.S.
Sir Henry Thompson, Bart.
Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S.

Admiral Sir Erasmus Ommanney, K.C.B., F.R.S.

Members of Council.

G. L. Alward, Esq.
G. P. Bidder, Esq.
G. C. Bourne, Esq.
Prof. J. B. Farmer, F.R.S.
G. Herbert Fowler, Esq.
S. F. Harmer, Esq., F.R.S.
Prof. W. A. Herdman, F.R.S.
Prof. G. B. Howes, F.R.S.
J. J. Lister, Esq., F.R.S.
H. R. Mill, Esq.
Prof. E. A. Minchin.
Prof. Charles Stewart, F.R.S.
Prof. D'Arcy W. Thompson, C.B.
R. N. Wolfenden, Esq., M.D.

Hon. Treasurer.

J. A. Travers, Esq.

Hon. Secretary.

E. J. Allen, Esq., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council:—

J. P. Thomasson, Esq.
The Prime Warden of the Fishmongers' Company.
E. L. Beckwith, Esq. (Fishmongers' Company).
Prof. Sir J. Burdon Sanderson, Bart., F.R.S. (Oxford University).
A. E. Shipley, Esq. (Cambridge University).
Prof. W. F. R. Weldon, F.R.S. (British Association).

Dr. *Statement of Receipts and Expenditure for the Year ending 31st May, 1903.* *Cr.*

		£	s.	d.	£	s.	d.
To Balance from last year, being Cash at Bank and in hand, viz.:—							
Balance of Plant Repairs and Renewals Fund		66	10	8			
Less Amount overpaid on General Account		29	18	1	36	12	7
„ Current Income:—							
H.M. Treasury		1,000	0	0			
Fishmongers' Company (including half-year's payment of £200 on account of year to 31st May, 1904)		400	0	0			
Annual Subscriptions		122	16	0			
Rent of Tables		17	15	0			
Interest on Investment		18	15	5			
Sales of Journal	£6 13 5						
Less Cost of Printing, etc.	4 2 6	2	10	11	1,561	17	4
„ Extraordinary Receipts:—							
Life Member's Composition Fee—H. G. T. Major					15	15	0
„ Balance, being amount due to Bankers		156	3	11			
Less Cash in hand, including £30 in hands of Naturalist on account of expenses		39	2	11	117	1	0
					£1,731	5	11

[Note.—This liability is exclusive of the amount held to be necessary as a Plant Repairs and Renewals Fund, which, with £25 added during the year, should stand at £91 10*s.* 8*d.*]

Investment held 31st May, 1903, £500 Forth Bridge Railway 4% Guaranteed Stock.

		£	s.	d.	£	s.	d.
By Current Expenditure:—							
Salaries and Wages—							
Director		200	0	0			
Naturalist		250	0	0			
Naturalist's Assistant		108	6	8			
Director's Assistant		148	0	0			
Wages		510	3	0	1,216	9	8
Travelling Expenses					16	2	0
Library					89	6	6
Buildings and Public Tank Room—							
Gas, Water, Coal, etc.		91	19	2			
Stocking Tanks, Feeding, etc.		29	5	0			
Maintenance and Renewals		95	13	5			
Rent of Land, Rates, Taxes, and Insurance		15	9	0			
		232	6	7			
Less Admissions to Tank Room		137	9	4	94	17	3
Laboratory, Boats, and Sundry Expenses—							
Stationery, Office Printing, Postage, etc.		123	6	9			
Glass, Chemicals, and Apparatus	£95 0 2						
Less Sales	11 8 11	83	11	3			
Purchase of Specimens		51	1	5			
Maintenance and Renewals of Boats, Nets, Gear, etc.	£293 15 1						
Less Sales	61 18 8	231	16	5			
Coal and Water for Steamer		113	5	4			
Insurance of Steamer and Boiler		26	5	4			
Boat Hire		0	16	0			
		630	2	6			
Less Sales of Specimens	£292 19 6						
Sales of Fish	22 12 6	315	12	0	314	10	6
					£1,731	5	11

Examined and found correct,
(Signed) Edwin Waterhouse, F.C.A.
R. Norris Wolfenden.
T. H. Riches.

June 22nd, 1903.

Director's Report.

THE Report of the Council, which has already been in the hands of the members of the Association for some months, and is reprinted in the present number of the Journal, gives a summary of the history of the Association and of the work which has been in progress since the issue of the last Journal.

It will be readily understood that the work of organising and commencing to carry out a programme of investigations of the size of the International scheme has placed a serious strain upon the members of the old staff of the Association, and whilst expressing the regret of myself and my colleagues at our apparent neglect in not having for some time provided the Council with the material necessary for the issue of a number of the Journal, I hope that during the next few months we shall demonstrate, by the publication of work which is on the verge of completion, that although silent we have not been idle, and that steady and substantial progress has been made with the various researches which we have in hand.

The ordinary work of the Plymouth Laboratory has continued with little if any interruption. The following naturalists have occupied tables during the summer, that is to say, since the publication of the list given in the Report of the Council on p. 640:—

The Rev. Canon Norman, F.R.S. (*Crustacea*).
Prof. W. F. R. Weldon, F.R.S., Oxford (*Variation of Mollusca*).
Dr. E. G. Gardiner, Wood's Hole (*Turbellaria*).
Dr. C. Shearer, Cambridge (*Development of Polychæta*).
G. F. Farran, B.A., Dublin (*Nudibranchiata*).
G. P. Bidder, M.A., Cambridge (*Method of measuring bottom currents in the sea*).
J. S. Thomson, Plymouth (*Fishes*).
W. R. G. Bond, B.A., Oxford (*General Zoology*).
F. W. W. Griffin, B.A., Cambridge (*Fishes*).
F. Cavers, B.Sc., Plymouth.
Rev. A Cole, Berkhamstead (*General Zoology*).
Miss J. Sollas, Cambridge (*Echinoderma*).
Miss A. Kelly, PH.D., Strassburg (*Chemical Physiology*).
Miss R. M. Clark, Cambridge (*Polyzoa*).
Miss E. Peacey, Oxford (*General Zoology*).

Prof. Otto Pettersson of Stockholm, Vice-President of the Central Bureau of the International Investigations, and Dr. P. P. C. Hoek of Copenhagen, General Secretary of the Central Bureau, have visited the Laboratories at Plymouth and Lowestoft in order to make themselves acquainted with the details of the work being carried on in connection with the investigations. They expressed their satisfaction with the arrangements that had been made at both stations, and with the progress of the researches.

The business of supplying specimens for scientific research, for teaching purposes, and for museums continues to grow. Unfortunately the expense involved in procuring constant supplies of fresh material will in all probability never allow of this branch of our work becoming entirely self-supporting, but the service rendered would seem to be of such value that it would be a distinct misfortune if it were allowed to cease.

As regards the fishery work of the Association, the policy adopted by the Council has been to throw all its energies, for the time being, into the prosecution of the International investigations, so that as far as the responsibility rests with them they may ensure the success of that important undertaking, and English fishery science may take its proper place as compared with that of the other countries of Europe.

The new members of the staff now employed by the Council in connection with these investigations have entered upon their duties with energy and enthusiasm, and share with the old a determination that the work produced shall be of such a character that even those who in the past have felt it their duty to offer criticism of the scheme shall be compelled to recognise its value and the possibilities it offers of producing results which will be both scientific and practical.

The reports on these International investigations will appear partly in the Bulletin of the Central Bureau, and partly in a separate publication.

E. J. ALLEN,
Director.

PLYMOUTH,
December 1st, 1903.

MAY 3 1904

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WILLIAM BRENDON AND SON, PRINTERS, PLYMOUTH.

OBJECTS

OF THE

Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the late Duke of ARGYLL, the late Sir LYON PLAYFAIR, Lord AVEBURY, Sir JOHN HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food-fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent for the use of a working table in the Laboratory and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing-boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff.

In the summer of 1902 the Association was commissioned by His Majesty's Government to carry out in the southern British area the scheme of International Fishery Investigations adopted by the Conference of European Powers which met at Christiania in 1901. In connection with this work a laboratory has been opened at Lowestoft.

The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

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